

DOCTORAL THESIS

A Longitudinal Investigation of the Social, Cognitive and Social Cognitive Predictors of Reading Comprehension

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A Longitudinal Investigation of the Social, Cognitive and Social Cognitive Predictors of Reading Comprehension

By

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A thesis submitted in partial fulfilment of the
requirements for the degree of PhD

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Abstract

This thesis reports a longitudinal investigation of social, cognitive and social cognitive predictors of early reading comprehension in a sample of 98 typically developing children. Children were aged three at the beginning of the study and, importantly, they were all non-readers and had not experienced formal literacy instruction. Children's progress in literacy-related development was reassessed over the following 28 months. Reading comprehension was assessed at the final time point, when children were six years old.

The first study investigated the influence of children's home literacy environment (HLE) on their cognitive pre-reading abilities at three years, and on their emergent literacy skills at five years. The second study considered the Simple View of Reading (SVR) to examine direct and indirect predictive pathways from children's preschool cognitive abilities to reading comprehension skills at the age of six. Thirdly, the role of theory of mind was explored to determine whether it contributed to reading comprehension over and above the SVR framework. The final study examined the retrospective and concurrent profiles of children identified at six years as *poor* and *good* comprehenders.

Results showed that children's preschool HLE experiences, and early cognitive abilities at three years, both directly and indirectly related to later reading comprehension at six years old. The SVR was extended to a younger population; children's reading comprehension was underpinned by two separate sets of preschool cognitive skills (code-related and oral language) contributing to two predictive pathways to later reading comprehension, suggesting that *both* word

reading and oral language skills are equally crucial for the acquisition of reading comprehension. Additionally, early theory of mind (potentially indexing metacognition) contributed to reading comprehension over and above the two components of the SVR, suggesting that the SVR may be too simple to fully account for emergent reading comprehension. The cognitive profiles of poor and good comprehenders added further evidence to suggest that preschool abilities may be important predictors of later reading comprehension skills.

The findings of this research have important practical implications, not only for the early identification of children who are at risk for future reading comprehension difficulties, but also for informing early years literacy instruction and future targeted interventions.

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Ethics approval

The research for this project was submitted for ethics consideration under the references PSY 09/043 PSY 11/025 in the School of Human and Life Sciences and were approved under the procedures of the University of Roehampton's Ethics Committee on 15th December 2009 and 28th July 2011 respectively.

Chapter 1 General introduction

“Comprehension is the essence of reading” (Durkin, 1993)

1.1 Introduction

The ultimate goal of reading is to comprehend the author’s message.

Comprehension is a crucial component in the development of children’s reading skills, and essential not only for academic learning, but also for learning and accessing information across the lifespan. Difficulties in comprehending will inevitably lead to widespread implications (National Institute of Child Health and Human Development (NICHD), 2005).

The National Early Literacy Panel (Lonigan, Schatschneider, & Westberg, 2008) defined two categories of literacy skills: emergent and conventional. Emergent literacy includes code-related skills, such as alphabetic knowledge (both letter names and sounds), knowledge of print concepts (i.e., knowledge of print forms and conventions), and language-processing skills, such as oral language (receptive and expressive) and phonological awareness. These skills precede, and predict, conventional literacy (Catts, Fey, Zhang, & Tomblin, 1999; Melby-Lervåg, Lyster, & Hulme, 2012; Sénéchal & LeFevre, 2002). Conventional literacy is the ability to read words accurately, fluently and efficiently, with the ability to comprehend the words in context. Put simply, emergent literacy is ‘learning to read’, whereas conventional literacy is ‘reading to learn’. Conventional literacy is crucial for accessing a self-directed educational curriculum and is strongly associated with educational achievement (Pretorius, 2000). Beyond educational learning, conventional literacy skills are a necessity for functioning in every-day

life. Research has established significant positive correlations between reading ability and employment (Wright & Stenner, 1999) and between reading and general health and wellbeing (Datar, Sturm, & Magnabosco, 2004; Eveland-Sayers, Farley, Fuller, Morgan, & Caputo, 2009).

Reading comprehension is a complex and multifaceted process; however it is supported through two core processes. The first is decoding the symbols and identify words, and the second is integrating the meaning of words in the context of the text (Gough & Tunmer, 1986). The Simple View of Reading (SVR; Gough & Tunmer, 1986; Hoover & Gough, 1990) proposes that reading comprehension is the *product* of decoding and linguistic comprehension, such that both components are necessary for successful reading comprehension and neither component is sufficient on its own (see 1.2.1 for further discussion). Typically, decoding and comprehension of the words develop together (Gough, Hoover, & Peterson, 1996). However, the relative importance of the two core processes change over time; in early childhood, decoding skills are the key predictors of reading comprehension, but by later childhood and the onset of adolescence, oral language skills assume greater importance (Adlof, Catts, & Lee, 2010).

With growing evidence that deficits in children's reading abilities can be prevented through early intervention (Partanen & Siegel, 2014; Velluntino et al., 1996), it has become essential to identify potential markers for reading problems as early as possible. Identifying skills in the first years of life, which predict later achievements, gives a better understanding of learning trajectories and ultimately helps the implementation of cost effective early interventions (NICHD, 2005). However, reading comprehension impairments, in particular, are difficult to

diagnose in the early school years, as deficits may be masked by adequate decoding skills. Therefore it is crucial to gain an understanding of *all* components underpinning the successful acquisition of reading comprehension.

Over past decades, the majority of research in emergent literacy has focused on word identification and decoding skills (Castles & Coltheart, 2004; Melby-Lervåg et al., 2012). To date, research investigating the development of reading comprehension has focused on school-aged children, after adequate decoding skills have become established (Cain, Oakhill, & Lemmon, 2004b; Catts, Adlof, & Weismer, 2006, Nation & Snowling, 1999). Additionally, the majority of studies have investigated the correlates of reading comprehension difficulties in unexpected poor comprehenders, i.e., children with reading comprehension problems in the absence of word reading deficits. Identifying children who may be at risk of later comprehension deficits during the very first stages of their education would allow the introduction of early, targeted interventions. It is therefore crucial to investigate the factors and skills underpinning the acquisition of reading comprehension in a typically developing population. To address this aim, the current study examined emergent literacy skills in a sample of typically developing three to four-year-old pre-readers, and followed their progress through preschool and the first two years of formal education, as they developed the skills required for successful reading and comprehension.

The research reported in this thesis was conducted as part of a larger investigation examining early predictors of reading ability through the first years of formal literacy instruction in the UK. The purpose of this thesis is to examine social, cognitive and socio-cognitive factors that contribute to individual

differences in the acquisition of reading comprehension. Specifically, this research examines the role of the home literacy environment, cognitive factors (decoding-related, oral language and executive function) and higher-order socio-cognitive ability (theory of mind) framed within the Simple View of Reading (SVR; Gough & Tunmer, 1986; Hoover & Gough, 1990). This opening chapter introduces the SVR, along with a brief review of a wider outlook of reading comprehension: the Reading Systems Framework (Perfetti, 1999; Perfetti & Stafura, 2014). The acquisition of reading comprehension is then discussed, followed by a review of the literature regarding the acquisition and development of decoding and oral language skills, executive function and theory of mind. The chapter ends with a review of the role of environmental factors (print knowledge and home literacy environment) in emergent literacy.

1.2 Models of reading comprehension

1.2.1 The Simple View of Reading

The Simple View of Reading (SVR; Gough & Tunmer, 1986; Hoover & Gough, 1990) provides a concise framework describing the components required for reading comprehension. The SVR posits that reading comprehension is the product of decoding and linguistic comprehension. The authors suggest that the two dimensions are necessary, of equal importance and both independently contribute to reading comprehension (Hoover & Gough, 1990). Decoding is defined as efficient word recognition, where the reader has the ability to derive a representation from text and access the appropriate mental lexicon to retrieve semantic information at word level. Linguistic comprehension is defined as the ability to take semantic information at word level and develop sentence and

discourse interpretations. The authors do not dismiss the complexities of reading comprehension, but argue that the components can be divided into two parts represented by decoding and linguistic comprehension. Other potential contributors to the reading process, e.g., motivation, home environment, general cognitive ability, are not discounted, but advocates of the SVR propose that decoding and linguistic comprehension are the core competences underpinning reading comprehension (Tunmer & Chapman, 2012a).

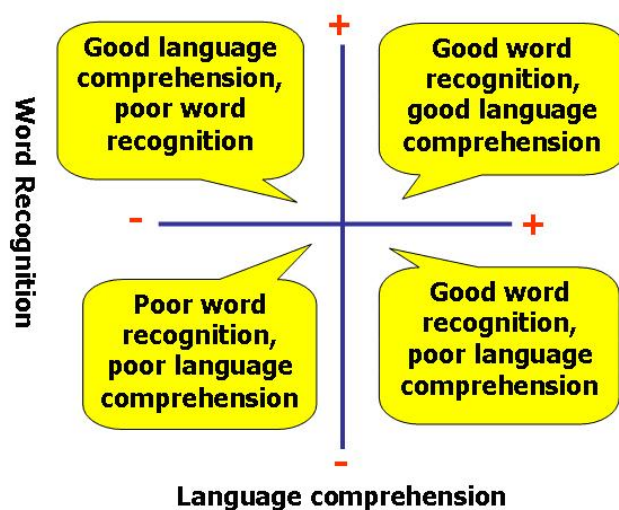


Figure 1.1. The Simple View of Reading (Gough & Tunmer, 1986)

In general, empirical research has supported the validity of the SVR. Studies investigating variability in reading comprehension for 8 to 16 year-old children have reported that the SVR accounts for 40% to 80% of variance (Catts, Adlof, Hogan, & Weismer, 2005; Johnston & Kirby, 2006; Joshi & Aaron, 2000; Savage, 2006). As a conceptual framework, the SVR has had direct influence in educational practices, where curricula have been designed to incorporate targeted teaching for both decoding and comprehension skills (Kendeou et al., 2005; Kendeou, van den Broek, White, & Lynch, 2007; Oakhill, Cain, & Bryant, 2003). Indeed, in the UK, following an independent review of the teaching of early

reading (Rose, 2006), the SVR model has been adopted as the theoretical foundation of the national literacy strategy in all English schools (Department for Education & Skills (DfES), 2006).

The SVR proposes that the decoding and linguistic comprehension components are distinct. Evidence, using factor analysis, has supported this aspect of the SVR, by showing that two differentiated components can be constructed from a greater set of measures (de Jong & van der Leij, 2002; Kendeou, Savage, & van den Broek, 2009a). Further evidence has also been reported to suggest that different skill sets underpin the development of decoding and linguistic comprehension skills in school-aged children. Letter knowledge, word identification, phonological awareness and print knowledge have been shown to support decoding skills, whereas linguistic comprehension is supported by vocabulary knowledge and listening comprehension (Kendeou et al., 2005, Kendeou et al., 2009a; Muter, Hulme, Snowling, & Stevenson, 2004; Storch & Whitehurst, 2002). Additionally, research with samples of children demonstrating comprehension difficulties has resulted in the identification of a range of different profiles, consistent with the categories suggested by the SVR (see figure 1.1) (Cain, Oakhill, & Bryant, 2004a; Catts, Hogan, & Adlof, 2005; Nation & Snowling, 1999). In a USA sample of 152 identified poor readers in Grade 8 (12-13 year olds), Catts et al. (2005) found that 36% showed difficulties in both word reading and listening comprehension skills, 36% had word reading deficits with adequate listening comprehension skills and 15% had adequate word reading skills but demonstrated difficulties in listening comprehension. In the UK, screening in typically developing populations of 7-10 year olds has resulted in approximately 10% being classified as 'poor comprehenders', i.e., those children with reading comprehension difficulties, but

normal-for-age text reading accuracy (Nation & Snowling, 1997). See 1.3.4 for further discussion of the ‘poor comprehender’ profile.

There is less evidence to support the distinction between skill sets underpinning the two dimensions of the SVR (decoding and language comprehension) in younger, pre-reading children and through the early stages of reading comprehension acquisition. Indeed, recent research has provided evidence to suggest that components of the skill sets are significantly inter-correlated in the early years (Kendeou, van den Broek, White, & Lynch, 2009b; NICHD, 2005).

The ambiguity relating to the degree of distinction between the two dimensions is partially due to how the constructs of decoding and language comprehension are conceptualized by different researchers (Kirby & Savage, 2008; Tunmer & Chapman, 2012a). Within the SVR framework, the decoding dimension is developmentally constrained. In the early stages of learning to read, letter to sound relationships play a key role and non-word reading is an accurate measure of decoding ability. In later stages, single word reading assesses the growth and development of sight word knowledge. However, to fully conceptualize the construct as suggested by the SVR, a measure of timed word recognition should also be included to capture the development of fluent reading. Ideally, a composite of all three measures is the most desirable strategy (Tunmer & Chapman, 2012a). Some researchers have argued that the SVR should include a separate fluency component to address the issue of reading efficiency (Adlof, Catts, & Little, 2006; Braze, Tabor, Shankweiler, & Mencl, 2007); however research evidence has been mixed and there has been limited evidence to suggest that fluency accounted for unique variance in reading comprehension over and

above the two dimensions (Cutting & Scarborough, 2006; Georgiou, Das, & Hayward, 2009; Kirby & Savage, 2008).

Similarly, there has been variation in the conceptualization of linguistic comprehension. Some research has equated listening comprehension to linguistic comprehension (e.g., Oullette & Beers, 2010), whereas the hypothetical construct suggested by the SVR is a richer measure of oral language abilities, which extends beyond listening comprehension to also include the employment of other language skills (e.g., vocabulary, semantics, syntax) to access the intended meaning of words and build a meaningful discourse in context (Gough & Tunmer, 1986). More recent research has suggested that vocabulary and the discourse aspects of language comprehension may contribute to reading comprehension in different ways and that oral vocabulary knowledge should constitute an additional component (Blaze et al., 2007; Oullette & Beers, 2010). Oullette & Beers (2010) reported that vocabulary uniquely accounted for variance in reading comprehension in Grade 6, but listening comprehension did not account for any further variance after controlling for vocabulary. In contrast, other researchers argue that vocabulary knowledge and listening comprehension load as a distinct factor (Kendeou et al., 2009a; Tunmer & Chapman, 2012a). However, evidence is mounting to suggest that oral vocabulary knowledge may play a significant role in both decoding and linguistic comprehension (Tunmer & Chapman, 2012a).

Tunmer and Chapman (2012a) investigated the contribution of vocabulary knowledge to the decoding dimension and the linguistic dimension of the SVR in a sample of 122 children in Grade 3 (7 year olds). Although regression analysis

indicated that vocabulary made a direct contribution to reading comprehension, exploratory factor analysis showed that vocabulary and listening comprehension loaded on a single factor, linguistic comprehension, and that it was independent of decoding. They reported from further analyses, using structural equation modelling, that the latent construct of linguistic comprehension *directly* contributed to reading comprehension, in line with the SVR. However, in addition, they also reported that linguistic comprehension *indirectly* influenced reading comprehension through the decoding construct, but decoding did not significantly influence linguistic comprehension. These data supported previous research that had examined the structure of the SVR within a sample of younger, preschool children (Kendeou et al., 2009a). Kendeou et al. (2009b) reported a significant, direct path from oral language skills (vocabulary, listening comprehension, television comprehension) at four years to decoding skills (phonological awareness, word and letter identification) at five years, but the path from early decoding skills to later oral language skills was not significant. Tunmer and Chapman (2012a) conclude that the two-component model of the SVR should not change, but the assumption that the components are fully independent and distinct may need to be revised, particularly for the early years. The literature regarding the early association between the dimensions is discussed in greater detail in section 1.4.1.3.

1.2.2 The Reading Systems Framework

Historically, models of reading comprehension were developed to represent “bottom up” processes starting with the word level or microstructure of the text, such as the construction-integration (CI) model (Kintsch, 1988) and moving up to

comprehension. However, “top down” approaches have also been taken, starting with the activation of prior knowledge and its integration with the information of the text to construct a situation model or mental representation of the situation described by the text (Van Dijk & Kintsch, 1983). More recently, research has built on these models to demonstrate that reading comprehension may be better explained through the combination and interaction of both processes (Kintsch & Rawson, 2005; Perfetti, Landi, & Oakhill, 2005; Perfetti & Stafura, 2014). One important focus of these enriched theories has been the inclusion of inference making and its crucial contribution in building and maintaining coherence within text reading (Graesser, Singer, & Trabasso, 1994).

Due to the complexity of reading comprehension, global frameworks rather than specified models have been proposed to explain the processes supporting comprehension. The SVR, as previously discussed, arose from the assumption that reading comprehension is the product of printed word identification and linguistic comprehension (Gough & Tunmer, 1986; Hoover & Gough, 1990). Its simplicity has provided an influential framework with widespread implications for research and education. However, more recently, further, more complex frameworks have aimed to capture the component subsystems to propose a general reading framework. The Reading Systems Framework (see figure 1.2) incorporates the components of reading from visual processing through to the contribution of previous knowledge and higher-level comprehension processes (Perfetti, 1999; Perfetti et al., 2005; Perfetti & Stafura, 2014). The framework proposes that there are three knowledge systems: linguistic knowledge (an understanding of phonology, syntax and semantics), orthographic knowledge (knowledge of mapping between phonemes and graphemes) and general

knowledge (including knowledge of print concepts and genres). These knowledge sources are used in either a constrained or interactive way to support reading processes, for example, word identification would use linguistic and orthographic knowledge, but not general knowledge, whereas inference-making would involve an interaction of all sources. The authors propose that the processes work within a resource-limited cognitive system linked to perceptual and long-term memory.

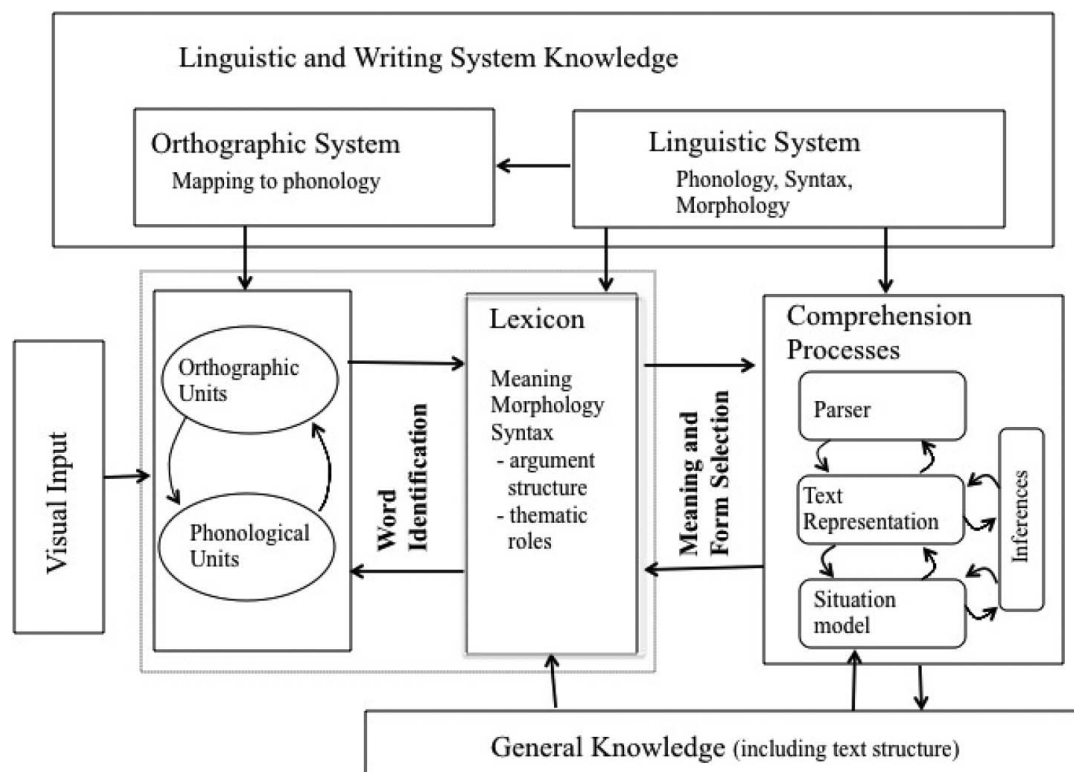


Figure 1.2. The Reading Systems Framework (Perfetti, 1999; Perfetti & Stafura, 2014)

The lexicon is central to the Reading Systems Framework, linking the word identification system and the comprehension system. Building on his Lexical Quality Hypothesis (LQH; Perfetti, 2007), which argues that reading comprehension depends on quality of the representation of the words, Perfetti and colleagues hypothesized that the lexicon is a potential “pressure point” in the

cognitive system and, therefore, a prime contender at the root of comprehension deficits (Perfetti & Stafura, 2014). The LQH (Perfetti, 2007) proposes that high lexical quality includes well-specified representations of the form of words (orthographically and phonologically) and a flexible representation of meaning. These high quality representations allow fast and reliable retrieval when reading text, releasing cognitive resources for comprehension processes. In contrast, poor lexical quality, with poor word representations (semantic, phonological and orthographic) leads to poor retrieval, which has consequences in processing speed at lexical level and the ability to integrate current words with prior text. Overall, poor lexical quality leads to slow and effortful reading, with limited resources available for comprehension processes (Perfetti, 2007).

The Reading Systems Framework proposes that successful comprehension initially requires the reader to efficiently use linguistic and orthographic information for rapid word identification. Semantic units within the lexicon are then activated to access the meaning. Finally, the word is inputted into the comprehension system to build meaningful units or propositions, which are then integrated into a mental model of the text (the situation model). This process may create a new model or update and extend a current model. However, the links are bidirectional and selection of word meanings in the semantic phase will be influenced by the reader's current representation of the text. Additionally, overall word identification and knowledge will be enhanced by contribution from the word comprehension system. These integration processes are crucial to comprehension and allow the reader to continually update their current understanding of the text to maintain coherence.

Successful comprehension skills crucially rely on the word-to-text integration processes and, as the knowledge of the use and meanings of words show variability across populations, individual differences in these processes may account for differences in comprehension ability (Perfetti & Stafura, 2014).

Individual differences influencing comprehension may be found in the breadth of vocabulary, or in the word knowledge required to support the correct meaning of a word in a specific context. The impact of vocabulary on reading comprehension was assumed to be indirect through its role in language comprehension.

However, direct effects have been found between early vocabulary and reading comprehension (Ouellette & Beers, 2010; Protopapas, Sideridis, Mouzaki, & Simos, 2007; Verhoeven & Van Leeuwe, 2008). As noted earlier (see section 1.2.1) a recent review of the SVR has acknowledged that linguistic comprehension (including vocabulary knowledge) influences decoding, mediating this direct effect between vocabulary knowledge and reading comprehension (Tunmer & Chapman, 2012a). This view of the SVR is consistent with the LQH (Perfetti, 2007) that assumes that word knowledge, both form and meaning, is crucially at the core of reading comprehension.

1.3 The acquisition of reading comprehension

Reading comprehension depends on spoken language comprehension throughout acquisition and development. The relationship between the two is reciprocal, with experience and skill in one potentially affecting the other, resulting in positive 'Matthew effects' where the rich get richer (Stanovich, 1986). As children become better readers they increase their reading and read more challenging material. This leads to more learning opportunities to improve fluency and

vocabulary growth, which, in turn, develops richer knowledge and experience (Nation, 2005a). Individual differences in vocabulary knowledge emerge before schooling begins. Socio-economic status has been shown to influence children's verbal ability, especially vocabulary knowledge, accounting for more than 40% of variance in the rate of vocabulary growth of three year olds (Hart & Risley, 1992). After starting school, children's vocabulary grows dramatically, up to 3000 words per year between six and 18 years (Nagy & Herman, 1987). As previously noted, oral language skills, including vocabulary, are at the core of reading comprehension; however, during the acquisition of reading comprehension, it is word decoding and identification that is the limiting factor. As children develop adequate decoding skills, word identification becomes less of a limiting factor and other factors become more influential. The early development of decoding skills and oral language skills are reviewed in the following section (see 1.4.1).

Beyond the development of word identification skills, to provide an adequate level of word knowledge, other higher-level comprehension processes are also essential to gaining an understanding of the text (see figure 1.2). Literal meaning of the text is rarely the whole story; language in any form, written or spoken, is unlikely to be fully explicit. According to Perfetti et al. (2005), the mental representation built from reading a text (the situation model; Kintsch & Rawson, 2005) has to be enriched to build a deeper understanding of the meaning of the text. Perfetti et al. (2005) propose that this update of a mental representation of the text is achieved through the application of three additional higher-level comprehension processes: inference making, comprehension monitoring and sensitivity to story structure.

1.3.1 Inference making

In general, inferences are needed to make the text coherent. There are two types of inferences: text-connecting inferences require the reader to integrate information from different parts of the text to establish local coherence, and gap-filling inferences are needed to fill in missing details, using information from outside the text (general knowledge), in addition to information provided by the text, to give an integrated understanding of the text as a whole (Cain & Oakhill, 2009). Research has suggested that young children are able to make the same inferences as older children, but are less likely to make them spontaneously (Casteel & Simpson, 1991). Inference making uses processing resources and therefore this may explain the lack of inference generation in young children, as, in these early stages of reading development, decoding words is an effortful process and as such children are left with limited cognitive resources for inference-making (Perfetti, 1999). Other researchers have suggested that the availability of knowledge may influence inference-making ability (Barnes, Dennis, & Haefele-Kalvaitis, 1996; Yuill & Oakhill, 1991). Barnes et al. (1996) examined the effects of age and accessibility to an available knowledge base on the inference-making skills of 147 six to fifteen year olds. Children were exposed to a novel knowledge base prior to hearing a multi-episode story, where inferences from the story drew on the new knowledge base. They found that age-related differences in inference-making skills were still apparent, even though the required knowledge was available to all. Younger children did make inferences, particularly if the necessary knowledge was easily accessible, but they were not as skilled as the older readers, suggesting that the ability to make inferences has maturational effects beyond those related to decoding efficiency.

The majority of research investigating the causal status and effects of inference-making abilities in comprehension has focused on comparisons between less skilled comprehenders and their typically developing peers (Cain & Oakhill, 1999; Cain, Oakhill, Barnes, & Bryant, 2001; Nation & Snowling, 1997). In addition to comparing inference ability between age-matched children, a comprehension-matched paradigm has been developed with the aim of controlling for the effects of comprehension skills and reading experience (Cain & Oakhill, 1999). In one such study, a group of seven to eight year old less-skilled comprehenders were compared with an age-matched group of skilled comprehenders and a younger, comprehension-matched (CAM) group of six year olds (Cain & Oakhill, 1999). All three groups were required to answer questions, following the reading of text passages, which required them to make either text-connecting inferences (linking noun phrases in successive sentences for local coherence) or gap-filling inferences (global inferences to establish overall coherence of the text). Results showed that both the age-matched skilled readers and the CAM group were better at making text-connecting inferences than the less-skilled comprehenders. Cain and Oakhill (1999) suggested that less skilled comprehenders might have a poor representation of the text, as their performance improved when attention was drawn to the relevant information in the text. However, results for gap-filling inferences were less clear, as the skilled readers outperformed both of the other groups and the performance of the less-skilled readers did not improve even when they were directed to the information in the text. The authors suggest that poor comprehenders may have, in particular, a low standard of global coherence when reading text.

It was suggested that poor comprehenders fail to make these gap-filling inferences because they do not know when to apply relevant information (Cain & Oakhill, 1999). A further study determined that it was the lack of spontaneity in using relevant information rather than lack of knowledge per se (Cain et al., 2001). Cain et al. (2001) gave children a novel knowledge base about an imaginary planet and ensured, pre and post-test, that it had been fully learned. Children heard stories that were situated on the imaginary planet and were required to answer questions that needed integration of information of the knowledge base. Poor comprehenders still answered less inference questions than the skilled readers.

Other studies have investigated the role of working memory in inference making. Verbal working memory tasks have been found to significantly correlate with inference ability and reading comprehension (Oakhill et al., 2003); however, Oakhill et al. (2003) found that working memory was not a unique predictor of inference ability and, indeed, inference ability predicted reading comprehension over and above working memory, vocabulary skills and word reading ability. A recent longitudinal study has supported the predictive nature of inference ability (Oakhill & Cain, 2012). The study investigated the predictors of reading comprehension in children between Year 3 (7 to 8 years) and Year 6 (10 to 11 years). Inference ability (also comprehension monitoring and sensitivity to story structure) emerged as significant predictors of later reading comprehension and the authors propose that early inference skills are causally related to the development of reading comprehension.

1.3.2 Comprehension monitoring

Skilled readers monitor their comprehension as they endeavour to achieve a coherent understanding of the text and introduce reread and repair strategies whenever there is a breakdown of understanding (Perfetti et al., 2005). Poor readers of all age levels do not appear to monitor their comprehension, but why this fails to happen is not clearly understood. Studies examining comprehension monitoring suggest that it may be related to establishing coherence of the text in a similar way to inferencing (Yuill, Oakhill, & Parkin, 1989; Perfetti et al., 2005). In their longitudinal study, Oakhill and Cain (2012) reported that early comprehension monitoring was significantly related to later reading comprehension ability. They argued for a causal link, as they also found that ability at eight years predicted reading comprehension at 10 years. The authors further suggested that this relation might be bidirectional, as they also found evidence that comprehension skill at seven years predicted monitoring ability at eight years.

1.3.3 Sensitivity to story structure

Research has suggested that young children use knowledge about human intentions and goal-directed action to regulate the temporal structure and build coherence of the narratives that they generate (Stein & Albro, 1997). Stein and Albro (1997) argue that children may acquire this knowledge by the age of three, and by the age of five use this understanding to develop strategies to create overall coherence within stories that have more than one episode. Narrative comprehension in these very young children is a foundation for later reading comprehension because, similarly to reading comprehension, children must

generate inferences, moderate their understanding and understand causal relationships to construct a coherent situation model of the text (Paris & Paris, 2003) (see 1.4.2 for further discussion of narrative comprehension).

Research with poor comprehenders has demonstrated that they are less likely to produce causally related stories than their more skilled reading peers, even if the task is supported with a series of pictures or a goal directed title (Cain, 2003; Cain & Oakhill, 1996). Less skilled comprehenders have difficulties in discriminating between aspects of a story (e.g., main theme, setting, main events) and perform poorly in story anagram tasks, which require them to sequence short stories from a series of sentences presented in random order (Cain & Oakhill, 2006).

Additionally, poor comprehenders produced less well-structured stories, when given a topic prompt, than age-matched skilled comprehenders and CAM matched groups (Cain, 2003). Cain and Oakhill (2009) reported a further study that asked children to elaborate on the information about a story that can be inferred from its title. They found that performance in this task was strongly related to concurrent reading comprehension tasks, but also predicted later reading comprehension. Sensitivity to story structure, along with comprehension monitoring and inference making, are crucial for constructing a rich mental representation of the meaning of the text that remains consistent, integrated and coherent in relation to the reader's general knowledge of the world.

1.3.4 Poor comprehender profile

Many children with comprehension deficits show impairments in decoding in addition to poor language skills (Norbury & Nation, 2011); however, 10 to 15% of

children demonstrate a 'poor comprehender' profile where the level of reading comprehension lags behind reading accuracy and chronological age expectations (Cain & Oakhill, 2006; Catts, Hogan, & Fey, 2003). In recent years, research has been conducted to investigate the correlates and cause of these comprehension deficits through the comparison of poor comprehenders with age-matched good comprehenders and to younger children matched on their comprehension ability (Cain & Oakhill, 1999, 2006; Cain, Oakhill, & Bryant, 2000; Cain et al., 2004a; Oakhill & Cain, 2012). Overall, Cain & colleagues have reported that poor comprehenders show difficulties with higher-level skills, such as inference making, comprehension monitoring, integration of text and working memory.

Other research has suggested that reading comprehension difficulties relate to deficits in general language comprehension, as poor comprehenders show weaker performance than typical readers and poor decoders on vocabulary and grammatical tasks (Catts et al., 2006). Further studies have found that poor comprehenders show weaker performance, relative to controls, on semantic skills, such as receptive and expressive vocabulary, and morphological processes (Nation, Clarke, Marshall, & Durand, 2004; Nation & Snowling, 1999; Nation, Snowling, & Clarke, 2007; Tong, Deacon, Kirby, Cain, & Parrila, 2011). In general, the results relating to language deficits support the Lexical Quality Hypothesis (Perfetti, 2007), suggesting that the quality of the lexical representation of words may be at the root of comprehension difficulties. Evidence, therefore, appears to suggest that poor comprehension, in the absence of word reading deficits, is related either at word level to poor semantic and morphological processing and/or at discourse level to weakness in higher level processing, such as working

memory and inference making. This profile is consistent with the SVR, as these skills can all be considered aspects of language comprehension (Li & Kirby, 2014).

The majority of research has examined the correlates of unexpected poor comprehension; causality is more challenging to establish, particularly as poor comprehenders are not typically identified before mid to late primary years. Two recent longitudinal studies have aimed to address the issue of causality (Oakhill & Cain, 2012; Nation, Cocksey, Taylor, & Bishop, 2010). Oakhill and Cain (2012) report findings from a four-year longitudinal study, investigating the predictors of reading comprehension and reading accuracy. Their study assessed the progress of children from Year 3 (7 to 8 years) to Year 6 (10 to 11 years). Results suggested that reading accuracy and reading comprehension were predicted by different skill sets, although verbal IQ and vocabulary contributed to both. Reading accuracy in Years 4 (8 to 9 years) and 6 was predicted by earlier word reading measures and phonological awareness (PA). Reading comprehension in Year 4 was predicted by Year 3 measures of reading comprehension, verbal IQ, vocabulary and sensitivity to story structure. Reading comprehension in Year 6 was predicted by Year 4 reading comprehension, and all three higher-order comprehension processes (inference, comprehension monitoring and sensitivity to story structure). Importantly, these comprehension processes predicted reading comprehension over and above the autoregressive effect of earlier reading comprehension and general language ability.

The second longitudinal study took a different approach. Nation et al. (2010) identified eight year-old poor comprehenders at the end of a study that had assessed children's language and reading skills from the age of five. From an

initial sample of 242 children, fifteen children met the criteria for poor comprehenders (using performance on a passage reading comprehension task to define poor comprehenders). The data for these children were compared to data from fifteen control children from the sample. Results confirmed that poor comprehenders demonstrated normal reading accuracy and fluency, and normal PA skills at all ages. However, they did show mild impairments in expressive and receptive language, listening comprehension and grammatical understanding at all ages. Additionally, their reading comprehension was poor at all assessment time points and the authors reported minimal growth in raw scores for reading comprehension between the ages of six and eight years. The authors suggest that causal inferences can be made from the fact that deficits in non-phonological oral language skills were present at five years old, and continued through the early primary years, before children had developed reading comprehension skills. The authors conclude that the language deficits could not result from the consequences of poor comprehension skills.

The current study aims to employ a similar methodological approach to extend knowledge of the early correlates of poor comprehension to a younger population (see Chapter 6). This project initially assessed pre-reading children at three to four years old, before they began fulltime education and formal literacy instruction. Reading comprehension was measured at six years old at the end of Year 1, after two years of full time education. Nation et al. (2010) reported that the poor comprehender group showed lower reading comprehension performance at all time points; therefore reading comprehension scores at 6 years in this current study ought to give a reliable indication of early reading comprehension ability allowing the categorization of good, average and poor

comprehenders. Similarly to Nation et al. (2010), this current study also used retrospective analysis to investigate earlier performance of each group with the aim of identifying early, preschool markers for potential reading comprehension strength and difficulties.

1.4 Precursors to reading comprehension

At the early stages of reading development, decoding is an effortful process and when cognitive resources are dedicated to decoding words there is less capacity available for comprehension (Perfetti, 1999). As a result word decoding is strongly associated with early reading comprehension performance.

Understandably, decoding skills are particularly influential in the earliest stages of reading comprehension (Adlof et al., 2010; Ouellette & Beers, 2010). Evidence has shown that reading accuracy significantly contributes to children's reading comprehension up to eight or nine years old (Sénéchal & LeFevre, 2002; Vellutino, Tunmer, Jaccard, & Chen, 2007). Ouellette and Beers (2010) reported that both single word and non-word reading uniquely accounted for variability in reading comprehension in a sample of five to seven year olds; but vocabulary and listening comprehension did not account for significant, unique variance.

However, in a sample of 11-12 year olds, vocabulary was a unique predictor of reading comprehension over and above decoding ability.

However, in order to successfully understand the meaning of text it is important to have semantic knowledge of the majority of individual words; it has been suggested that knowing at least 90% of the words in a text is required for adequate comprehension (Nagy & Scott, 2000). Therefore lexical semantics is at the core of reading comprehension (see figure 1.2), even through acquisition and

early development stages (Perfetti, 1999). The following section of this chapter will discuss the literature relating to early development of factors underpinning reading comprehension. In line with the SVR, the development of decoding-related processes and linguistic comprehension, and the early relationship between the skill sets, are discussed. Additionally, as executive function has been shown to play a role in the reading comprehension of older children (e.g., Cain et al., 2004a), the contribution of executive function skills to emergent literacy are also considered. Finally, given the evidence for the role of higher-order comprehension processes (e.g., inference making and comprehension monitoring) in reading comprehension in typically developing older children, the importance of metacognitive abilities in young children, as measured by theory-of-mind ability, will be discussed as a potential novel factor in facilitating reading comprehension. To date, the relationship between early theory of mind and reading comprehension has not been explored in young, typically developing children.

1.4.1 The development of emergent literacy skills

1.4.1.1 Decoding processes

It is generally understood that children read words in English in two different ways: phonological decoding or sight word recognition (Aaron et al., 1999; Ehri, 2005; Snow & Juel, 2005). Phonological decoding involves the identification of individual letters or combination of letters (graphemes) and mapping them to their corresponding sounds (phonemes). The sounds must then be blended together to pronounce the word. Sight word recognition involves remembering previously seen words and relies on memory. Regular words, with consistent

grapheme-phoneme correspondences, such as 'stand', can be read through phonological decoding or, once familiar, through whole word recognition. Irregular or exception words, such as 'yacht', with inconsistent grapheme-phoneme mapping, can only be read through sight word recognition. However, the distinction between reading regular and irregular words is not a binary process. Tunmer and Chapman (2012b) suggest that vocabulary knowledge plays a role on the growth of word recognition skills mediated through a variable called *set for variability*. Set for variability is the ability in which children learn to use decoding patterns to produce phonological representations that provide the foundation for generating alternative pronunciations of a word, until they produce a viable version that matches with a word in their listening memory and is appropriate in the context of the text (Venezky, 1999). Tunmer and Chapman (2012b), in their three-year longitudinal study of beginner readers, found that set for variability influenced later reading comprehension both directly and indirectly through decoding and word recognition.

1.4.1.1.1 Theoretical models of word reading

Past theoretical models of word reading have specified distinct stages of development (Frith, 1985). However, more recently it has been argued that stages overlap and the development of sight word reading is continuous. Ehri's (2005) *phase theory* consists of four components: pre-alphabetic, partial alphabetic, full alphabetic and consolidated alphabetic. During the pre alphabetic phase children rely on salient visual cues to identify words, such as two 'eyes' in 'look', but do not have sufficient ability to decode unfamiliar words. In the partial alphabetic phase they learn letter names and sounds, and begin to connect these to words, mostly

through use of the first or last letter. Children often confuse similarly spelt words during this phase, as they rely on initial letters and contextual clues to read unfamiliar words rather than using decoding strategies. Decoding strategies become available in the full alphabetic phase, when children begin to effectively map grapheme-phoneme correspondences. They begin to read words from memory; decoding strategies help them to retain the pronunciation and meaning of whole words. As children accumulate more whole and partial words in memory, they move to the consolidated alphabetic phase. Decoding strategies in this phase now include knowledge of syllabic and morphemic units and spelling patterns, making the process increasingly efficient.

1.4.1.1.2 Phonological processing

A wealth of empirical studies have produced evidence showing that phonological skills play a central role in the first stages of reading acquisition (e.g., Castles & Coltheart, 2004; Schatschneider, Fletcher, Francis, Carlson, & Foorman, 2004; Snowling & Hulme, 2012; Storch & Whitehurst, 2002). Preschool phonological awareness (PA) is a robust predictor of subsequent reading development (Hulme et al., 2002; Hulme, Bowyer-Crane, Carroll, Duff, & Snowling, 2012) and intervention studies have demonstrated that providing pre-readers with phonological awareness training improves their phonological skills and, to lesser extent, subsequent reading skills (Hatcher, Hulme, & Snowling, 2004). However, other researchers whilst acknowledging strong correlational relationships between phonological awareness and word reading, dispute the causal nature of the relationship suggesting that there is not sufficient evidence (see Castles & Coltheart, 2004).

More recently, researchers have investigated the effects of phonological awareness instruction. Phonemic awareness, in particular, has been reported to enhance word reading (Ehri et al., 2001). Phonemic awareness is a subcategory of phonological awareness, which involves the ability to identify and manipulate phonemes (the smallest unit of spoken sound). Boyer and Ehri (2011) conducted a study with four to five-year-old preschoolers to investigate the effects of phonemic awareness instruction. There were two experimental groups, where the first were taught associations between 15 graphemes and phonemes. The second group was taught the same associations, but they also learnt the explicit pronunciation of the phonemes using pictures to depict articulatory mouth positions for each phoneme. The third group received no instruction. The children subsequently completed a sight-word learning task. The children in the articulation group learned to read the words more quickly than the letter only group, but both experimental groups learned to read more words than the control group. The authors suggest that training, and particularly the addition of articulation instruction, improved the children's phonemic representations of words in memory, therefore concluding that phoneme awareness has a direct influence on word reading skills.

A further study reported a mediation analysis from a large-scale intervention project examining the effects of phoneme awareness and letter-sound knowledge instruction (Hulme et al., 2012). Hulme et al. (2012) found that the intervention that taught phoneme awareness and letter-sound knowledge, rather than one of the two skills alone, produced the greatest improvement in both of the skills and later word-reading ability. Improvements in the children's phoneme awareness and letter-sound knowledge mediated the growth of children's word reading

skills five months after the intervention had finished. The authors concluded that phoneme awareness and letter-sound knowledge are causally related to the development of children's early literacy skills.

Other aspects of phonological awareness have also been associated with word reading skills. Influential research conducted in the 1980's by Bradley and Bryant (1983) investigated the relationship between PA and reading performance. They compared PA skills of good and poor readers, reporting that skilled readers performed significantly better than poor readers on rhyming tasks. Over the past decades, a wealth of research has further examined the relationships between PA and reading. A recent meta-analysis (Melby-Lervåg et al., 2012) reviewed 135 correlational studies and reported an overall moderate correlation ($r = .43$) between rime awareness and word reading; however the correlation between phonemic awareness and reading was significantly higher ($r = .57$) suggesting that word identification may be more associated with phonemic awareness than rime awareness. Further evidence supporting this stronger association has been found in other studies. Muter et al. (2004) conducted a two-year longitudinal study of 90 children in the UK, beginning when the children were aged four to five years old. They found that early phoneme awareness significantly predicted later reading accuracy, but rime awareness did not.

The ability to map phonemes and graphemes is crucial for children to construct a reliable lexicon of sight words, and knowledge about the form and sounds of individual letters is a vital step in the development of this skill (Ehri, 2014; Share, 1995). Research has shown that preschoolers use the knowledge of shapes and names of letters to learn letter sounds (Cardoso-Martins, Mesquita, & Ehri, 2011;

Share, 2004). Further studies have reported that individual differences in letter knowledge remain stable from preschool through to early primary school and that it remains a separate skill independent of PA and word recognition (Lonigan, Burgess, & Anthony, 2000). Lonigan et al. (2000) found that letter knowledge (names and sounds) at four years predicted 72% of unique variance in letter knowledge at five and six years. They also found that letter knowledge at five years was a key independent predictor of word reading ability one year later at six years old. The Self-Teaching Hypothesis (Share, 1995) proposes that as children's reading develops, they begin to make independent use of letter-sound knowledge to identify unfamiliar words in the text. As a self-teaching mechanism, knowledge and experience of grapheme to phoneme correspondence enables children to independently acquire an autonomous orthographic lexicon.

1.4.1.2 Oral language skills

Whilst decoding skills appear to be the most influential precursors of early reading, broader language skills are considered to be stronger predictors of children's reading abilities from Grade 2 onwards, particularly of reading comprehension (Kendeou et al., 2009b; Vellutino et al., 2007). Some researchers have proposed that oral language skills are crucial to early reading comprehension (Paris & Paris, 2003) and others argue that these skills do not play a major role until sufficient decoding skills have been developed (Vellutino et al., 2007). It is clear that both language and decoding skill sets begin developing through the preschool years and that these skills are predictive of reading comprehension in the second grade (Kendeou et al., 2009b; Paris & Paris, 2003). However, it is difficult to gain a clear understanding of the developmental

trajectory of the contribution of language comprehension skills. The complexity of language and the intertwined development of its component skills are major reasons for the confusion and challenges in this field of research. Empirical studies are limited in their investigation of broader language skills, such as expressive language and narrative skills, particularly in young pre-readers, and receptive vocabulary is often the only measure of early language development (Dickinson, McCabe, Anastasopoulos, Peisner-Feinberg, & Poe, 2003; Muter et al., 2004; Schatschneider et al., 2004). As a result, the full contribution of language skills in the development of emergent literacy skills may be underestimated in the research literature (Dickinson, Golinkoff, & Hirsh-Pasek, 2010). Additionally, the impact of language skills may be also be undervalued in research, because their influence is often indirect. Dickinson et al. (2010) suggest that this may be due to the extended development of language skills, as opposed to code-related skills that develop rapidly through the early years.

In more recent studies, researchers have aimed to measure additional, broader aspects of oral-language, e.g., syntax, semantics and narrative recall (Bianco et al., 2012; Bowyer-Crane et al., 2008; de Jong & van der Leij; NICHD, 2005; Storch & Whitehurst, 2002), but there are still inconsistencies in reported findings, perhaps due to the diversity of later reading comprehension assessments. Some researchers use cloze tasks, where the participant is required to provide the missing word in a sentence to demonstrate their understanding (NICHD, 2005; Schatschneider et al., 2004), others use sentence comprehension (Leppänen, Niemi, Aunola, & Nurmi, 2006) and yet other studies have administered passage comprehension tasks (Catts, Fey, Tomblin, & Zhang, 2002; de Jong & van der Leij,

2002; Vellutino et al., 2007). As a result, comparison between studies to find supporting evidence is challenging.

1.4.1.2.1 Early language skills and narrative comprehension

Investigation of relationships between early language skills and reading comprehension during early school years is problematic due to the limited word identification and decoding skills of very young children. To address this issue, recent studies have begun to investigate the relationship between oral language skills and narrative listening comprehension ability in preschool children (Florit, Roch, & Levorato, 2011; Florit & Levorato, 2012; Lepola, Lynch, Laakkonen, Silvén, & Niemi, 2012) and the contribution of these oral language comprehension skills to later reading achievement (Bianco et al., 2012). Narrative listening comprehension has been found to be an important precursor to reading comprehension (Kendeou et al., 2009b) and a better understanding of the development of skills underpinning narrative comprehension may allow us to understand how these skills could be fostered in advance of reading comprehension. As such, this thesis included the investigation of the pre-reading skills supporting early listening comprehension and narrative comprehension. Subsequently, it examines the contribution of listening and narrative comprehension to reading comprehension.

Vocabulary knowledge has been shown to be a strong predictor of later reading comprehension (Muter et al., 2004; Ouellette & Beers, 2010; Roth, Speece, & Cooper, 2002) and narrative listening comprehension (Florit, Roch, Altoè, & Levorato, 2009; Kendeou, Bohn-Gettler, White, & van den Broek, 2008; Sénéchal,

Ouellette, & Rodney, 2006). In a cross sectional study of typically developing children, Florit et al. (2009) reported significant correlations between receptive vocabulary and listening comprehension at the age of four ($r = .45$) and five years ($r = .40$). Similar levels of association are found in studies examining longitudinal relationships, and receptive vocabulary has been shown to uniquely predict concurrent and later narrative listening comprehension (Florit et al., 2009; Kendeou et al., 2008; Sénéchal et al., 2006). Sénéchal et al. (2006) reported that receptive vocabulary accounted for 7% and 8% of unique variance in listening comprehension at kindergarten and Grade 1, respectively, after controlling for parent literacy, child age, literacy skills and phonological awareness. However, more recent studies have failed to demonstrate the direct link between vocabulary and later comprehension when the autoregressive effect of previous listening comprehension has been included (Bianco et al., 2012; Lepola et al., 2012). This suggests that early vocabulary knowledge may be important for the acquisition of listening comprehension, but, subsequently, comprehension processes (e.g., inference making) may account for individual differences in reading comprehension.

1.4.1.2.2 The role of vocabulary

The focus of building vocabulary may not be sufficient for improved literacy outcomes, and indeed oral language comprehension skills. Although vocabulary is, of course, essential for comprehension, it is not sufficient alone; more complex oral-language skills are crucial. However, it is vocabulary that provides the foundation for grammatical knowledge, definitional vocabulary and listening comprehension (Lonigan et al., 2008). The relation between the various language

skills remains complex and is likely to be bi-directional, therefore it is challenging to determine their independent contribution to emergent literacy. As noted, limited studies have used both vocabulary and broader measures of early language skills. However, studies with older school-aged children (Grades 2 and 3) have shown that definitional vocabulary, rather than receptive vocabulary, is more strongly associated to listening comprehension (Wise et al., 2010) and with reading comprehension in Grades 3 and 4 (Ouellette, 2006; Tannenbaum, Torgesen, & Wagner, 2006).

1.4.1.2.3 The role of the higher-order comprehension skills

A current field of research is investigating the contribution of the higher-order comprehension skills (inference making, sensitivity to story structure and comprehension monitoring) in school-aged children (Cain & Oakhill, 2009; Oakhill & Cain, 2012). These higher-order skills have also been demonstrated to play an important role in preschool narrative and listening comprehension of four year olds (Kendeou et al., 2008; Paris & Paris, 2003) and later reading comprehension of seven and eight year olds (Kendeou et al., 2009b). Kendeou et al. (2008) reported that inferential skills developed early across different types of medium, e.g., aural, televised and written stories, uniquely contributed to reading comprehension over and above decoding skills and vocabulary. Additionally, they argued that measuring children's comprehension as sensitivity to the causal structure of the narrative gave a richer measure than recall alone, as it provided an indication of children's ability to create global coherence of the narrative. This ability has been demonstrated to be a crucial factor of successful oral and reading

comprehension in older children (Kintsch & Rawson, 2005; Oakhill & Cain, 2012). See section 1.3 for further discussion.

1.4.1.2.4 The contribution of early narrative skills

Evidence is currently accumulating to suggest that early narrative skills, beyond vocabulary knowledge, contribute to reading comprehension at a much earlier stage than previously considered in the majority of the literature (Bianco et al., 2012). This highlights the need to examine the early contribution of these narrative skills and extend our current knowledge of their importance in the reading comprehension skills of older children (Cain & Oakhill, 2009). Currently, research in listening comprehension is scant. Although research has shown that children begin to understand complex narratives by four-years-old (Kendeou et al., 2008; Lepola et al., 2012; Skarakis-Doyle & Dempsey, 2008), less is known about which cognitive factors underpin these skills and their role in later reading comprehension. Studies have reported the unique roles of inference and vocabulary on listening comprehension (Florit et al., 2011; Kendeou et al., 2008) and a more recent study reported the longitudinal relationships between language skills and inference making skills at four years and narrative listening comprehension at six years old (Lepola et al., 2012). However, to date there is no study examining the longitudinal relationship between early preschool language skills and the acquisition of *reading* comprehension. The current study aimed to address this issue and reports on the relationships between early language skills at three years, listening comprehension at five years through to narrative and reading comprehension at the age of six.

1.4.1.3 Relationship between decoding and oral language skills

The SVR proposes that the two dimensions of word reading and language comprehension are distinct; however more recently it has been suggested that there is an association between the two dimensions, particularly in the early years (Tunmer & Chapman, 2012a) (see section 1.2.1 for discussion). Evidence suggests that language development is closely related to the development of decoding and phonological skills in the very early school years (Dickinson & McCabe, 2001; NICHD, 2005). During these years, broad language skills (vocabulary, oral comprehension, expressive, and receptive language) are found to be closely inter-related (Bianco et al., 2012; Catts et al., 1999; Kendeou et al., 2009b) and these early language skills appear to be predictive of decoding skills in pre-readers (Lonigan et al., 2000; Kendeou et al., 2009b; Storch & Whitehurst, 2002). Recent research supports this view, but suggests that although the two skill sets are inter-related during preschool, both still make a unique contribution to later reading comprehension (Kendeou et al., 2009b). Over time, the two skill sets develop relatively independently from each other, and both show considerable stability in terms of individual differences over development (Cain & Oakhill, 2009; Oakhill et al., 2003).

Vocabulary has also been shown to relate to the development of decoding skills (de Jong & van der Leij, 2002; Muter et al., 2004; Tunmer & Chapman, 2012a; Vellutino et al., 2007). Vocabulary appears to have a reciprocal relationship with phonological awareness (Dickinson et al., 2003; Lonigan et al., 2000) and to be a direct predictor of letter knowledge (Dickinson et al., 2003; Lonigan et al., 2000) and word identification (de Jong & van der Leij, 2002; Vellutino et al., 2007; Wagner et al., 1997). However, the limited studies that have assessed vocabulary

as well as broader measures of early language skills (e.g., receptive grammar, narrative skills) have found evidence that these broader language skills have a more potent impact on word identification than vocabulary alone (Catts et al., 1999; NICHD, 2005). Catts et al. (1999) showed that oral-language skills (vocabulary, receptive and expressive language, grammatical knowledge and narrative skills) were all significant predictors of second grade reading ability. The NICHD study (2005) followed 1,137 typically developing children from three years old to third grade (8 years old) and assessed their code-related (e.g., PA, letter-word knowledge) and broad oral-language skills, including vocabulary, expressive language and oral comprehension. Evidence from the study reported that expressive language and oral comprehension, but not vocabulary, at 54 months were directly and significantly related to word reading in the first grade, independent of code-related skills. These results suggest that broader language skills play a greater role than vocabulary in the development of word reading skills. Further evidence supporting this relation was found in a recent longitudinal study examining relationships between oral language comprehension and reading acquisition, two years later, in a sample of four-year-old French-speaking children (Bianco et al. 2012). Oral language comprehension, but not vocabulary, at four years significantly accounted for variance in word identification at six years, providing evidence that higher-order language skills, developed before learning to read, play a role in word recognition (Nation, 2009; Nation & Cocksey, 2009; NICHD, 2005) and are therefore clearly involved in the course of reading acquisition.

1.5 Summary: Is the Simple View of Reading too simple?

The Simple View of Reading (SVR; Gough & Tunmer, 1986; Hoover & Gough, 1990) aims to provide a model of the proximal causes of individual differences in reading comprehension (Tunmer & Chapman, 2012a). It proposes a framework to consider the complex nature of reading comprehension by suggesting that two distinct components, word recognition and linguistic comprehension, contribute equally and independently to reading comprehension. As previously discussed, each component can be further dissected into constituent processes, and these processes form distinct skills sets, with code-related skills such as letter knowledge and phonological awareness underpinning word reading skills, and oral language skills such as vocabulary and listening comprehension underpinning linguistic comprehension (Cutting & Scarborough, 2006; de Jong & van der Leij, 2002; Kendeou et al., 2005; Muter et al., 2004). Although separable in their relation to later reading comprehension, there is a considerable degree of correlation between the skill sets, particularly in the early years (Kendeou et al., 2009b; NICHD, 2005), suggesting that the SVR may still need to be clarified as an account of reading comprehension acquisition. For example, recent research has suggested that the independence of the SVR dimensions may need to be revised, particularly for the early years, as evidence has found a unidirectional direct pathway from oral language skills to decoding skills (Kendeou et al., 2009b; Tunmer & Chapman, 2012a).

Previous studies with older children that have investigated the variability in reading comprehension have found that the SVR accounts for 40% to 80% of variance in the reading comprehension ability of eight to 16 year olds (Catts et al.,

2005; Johnston & Kirby, 2006, Joshi & Aaron, 2000; Savage, 2006). Researchers are now considering the amount of variance in reading comprehension that remains unexplained by word recognition and linguistic comprehension skills (Kirby & Savage, 2008). Some researchers have argued that a third component (e.g., fluency, processing speed, naming speed) should be included in the SVR model (e.g., Adlof et al., 2006; Braze et al., 2007; Johnston & Kirby, 2006); however, data from these studies has yielded limited evidence that these potential candidates account for unique variance in reading comprehension over and above word recognition and linguistic comprehension. Less is known about the fit of the SVR model for the acquisition of reading comprehension, as typically children's reading comprehension is not assessed until mid-primary years.

Research has suggested that there are three domains of factors influencing literacy acquisition: cognitive, psychological, and ecological domains (Aaron, Joshi, Gooden, & Bentum, 2008). In general, the SVR accounts for the cognitive domain with the focus on the influence of proximal, direct factors, e.g., letter knowledge and vocabulary knowledge. Additionally, it recognizes that both SVR domains are directly and indirectly influenced by more distal cognitive factors such as phonological awareness (Tunmer & Chapman, 2012a; Vellutino et al., 2007). However, it does not consider the influence of higher-order cognitive factors (e.g., working memory) or metacognitive comprehension processes (e.g., comprehension monitoring) that may directly influence reading comprehension *over and above* the SVR dimensions (Kirby & Savage, 2008). Also it does not account for the influence of factors from the psychological (e.g., motivation and interest in reading) or ecological (e.g., home literacy environment) domains (Tunmer & Chapman, 2012a).

The primary aim of the current study is to examine the contribution of early pre-reading cognitive skills to the later acquisition of reading comprehension within the framework of the SVR. This chapter has reviewed the literature relating to the development and inter-relationships of cognitive factors underpinning word reading and oral language comprehension. However, as noted above, the SVR may be too simple to provide a comprehensive model for the acquisition of reading comprehension. This study aimed to examine this issue through the investigation of three additional factors that may potentially contribute to the development of early reading comprehension skills. The first is executive function. Existing research has established that executive function ability plays a role in emergent literacy (Blair & Razza, 2007; Welsh, Nix, Blair, Bierman, & Nelson, 2010) and in reading comprehension in older children (Cain et al., 2004a; Sesma, Mahone, Levine, Eason, & Cutting, 2009). However, its contribution to the *acquisition of reading comprehension* in a typically developing young sample remains unexplored.

The second factor is theory-of-mind ability. In a recent study of adolescents with autism spectrum disorders, Ricketts, Jones, Happé and Charman (2013) found that measures of theory of mind accounted for unique variance in reading comprehension beyond oral language skills and word reading ability. However, to date, there is no existing research examining the role of theory of mind in the acquisition of reading comprehension in a typically developing population. Higher order comprehension processes, e.g., comprehension monitoring, are considered by some researchers to be metacognitive processes (Kirby & Savage, 2008), therefore it seems plausible that theory of mind, as a measure of

metacognition (Flavell, Green, & Flavell, 2000; Perner, 1991), may directly contribute to early reading comprehension.

The third factor relates to environmental influences. Children begin to acquire knowledge of written language in conjunction with oral language development during the preschool years, within social contexts that provide exposure to the printed word (Whitehurst & Lonigan, 1998). The most prominent of these social contexts is the home literacy environment, in which children are exposed to a variety of print-related materials and experiences with family members, friends and primary caregivers.

The following sections of this chapter will review existing literature exploring the influence of higher-order cognitive factors (executive function), socio-cognitive ability (theory of mind) and environmental factors (exposure to print and home literacy environment) on emergent literacy and later reading comprehension.

1.5.1 The role of executive function

Mounting evidence has suggested that young children's working memory and inhibitory control are each important for academic performance through primary school (de Jong & van der Leij, 2002; McClelland et al., 2007; Seigneuric & Ehrlich, 2005; Seigneuric, Ehrlich, Oakhill, & Yuill, 2000), and in maths and reading in particular (Welsh et al., 2010). The development of these skills enables children to organise and focus thinking, leading to self-regulated and rule-governed behaviour (Gathercole et al., 2008). Welsh et al. (2010) found that working memory, measured at the beginning of the pre-kindergarten year, predicted

growth in emergent literacy during that academic year, when children were four years old. Other studies investigating cognitive inhibition have also reported links to literacy outcomes; McClelland et al. (2007) found cognitive inhibition predicted vocabulary and print knowledge in four year olds and continued to predict growth through the first school year. A further study found that children's task-focused behaviour (teacher's evaluation) was a predictor of kindergarten phonological awareness and letter knowledge (Stephenson, Parrila, Georgiou, & Kirby, 2008).

McClelland et al. (2007) investigated the importance of these skills during the preschool years, before children have begun formal education. They found that performance of four year olds on the Head-to-Toes task, an assessment of behavioural regulation that taps working memory, attention and inhibitory control, significantly predicted variance in early measures of letter knowledge, word reading and vocabulary. Additionally, they found that improved performance on the Head-to-Toes task over the preschool year predicted growth in the early literacy skills during the same time period.

Working memory, in particular, appears to be associated with literacy outcomes (Savage, Lavers, & Pillay, 2007). Working memory operates to keep relevant information on-line during problem solving and research has provided evidence to suggest that children's performance on working memory tasks accounts for variance in reading achievement (Blair & Razza, 2007; Gathercole, Alloway, Willis, & Adams, 2006). The hypothesis that an active working memory, rather than a passive short-term memory, is related to reading comprehension is well established (Perfetti et al., 2005; Seigeuric et al., 2000). Working memory can be

divided into four subcomponents: the central executive, which is considered to be an attention-controlling system, two slave systems consisting of the visuospatial sketch pad (which manipulates visual images) and the phonological loop (which stores and rehearses speech-based information) and the episodic buffer, which is a temporary store that integrates phonological, visual and spatial information into a unitary episodic representation (Baddeley, 1992, 2000). The phonological component has a direct link to reading comprehension through the need to keep the contents of a sentence active until integrative processes are activated, at which time verbatim memory is less important. Several studies have also found relationships between phonological awareness and working memory in early readers (Alloway, Gathercole, Willis, & Adams, 2004; Cutting & Denckla, 2001); however this relationship has not been found in older readers, suggesting that phonological awareness and working memory start as related processes, but diverge as in later primary school as reading develops (Savage et al., 2007).

Recently, a number of studies have found that verbal working memory plays an important role in listening comprehension skills among preschool and school-aged children (Florit et al., 2009). Florit et al. (2009) found that among preschool children working memory was a significant predictor of concurrent listening comprehension over and above receptive vocabulary and verbal IQ. Similarly to text comprehension, understanding aural narratives may require children to draw on their phonological working memory resources to integrate the meaning of several words in a sentence (Ouellette, 2006). Also phonological working memory resources are necessary for the child to integrate the meaning of currently held information with previous parts of the narrative and background knowledge (van den Broek & Lorch, 1993). However, to date, the association

between working memory capacity and the *acquisition* of reading comprehension remains relatively unexplored. The current study aimed to examine this relationship and investigated the role of early working memory ability at three, four and six years old to early reading comprehension at six years old.

1.5.2 The role of social cognition: theory of mind

As noted, research has produced evidence to suggest that aspects of executive function, particularly working memory, contribute to early literacy achievement (see 1.4.2) and to reading comprehension in older children (see 1.3.1). A recent study, with a sample of typically developing eight year olds, reported that one aspect of executive function, attentional control (defined as the ability to inhibit irrelevant responses and initiate alternative responses), predicted reading comprehension over and above language comprehension, decoding, processing speed and verbal short-term memory (Conners, 2009). Conners (2009) suggested that attentional control might contribute to reading comprehension through its role in detecting and repairing comprehension failures. However, other researchers argue that these comprehension processes, although drawing on executive function skills, ultimately depend on metacognitive abilities (Kirby & Savage, 2008).

Metacognition is a broad concept that encompasses many different aspects of a person's cognition about a cognitive object. Some researchers argue that one early measure of metacognitive processes is theory of mind (Flavell, 1987; Kuhn, 2000). Theory of mind is described as the ability to impute mental states, such as belief, desire, intentions and knowledge, in others in order to predict and explain

behaviour in oneself and others (Perner, 1991; Premack & Woodruff, 1978). Extensive research with preschool children over the past thirty years has investigated a crucial milestone in theory of mind development: the understanding of false belief (see Doherty, 2009 for overview; see Baillargeon, Scott, & He, 2010; Ruffman, 2014 for recent reviews). False belief understanding requires meta-representational understanding of mental states, i.e., understanding that a person can understand (represent) how someone else understands (represents) or misunderstands (misrepresents) a situation (Wellman, Cross, & Watson, 2001). False belief tasks require a child to understand that people's behaviour is based on what someone *thinks* is the case (i.e., that person's own mental state or mind) rather than what is the case (real world state), even though the child knows the real world situation. In other words, to be able to predict and explain another's behaviour, children must be aware that other people may act on the basis of a mistaken belief about a reality (Wellman et al., 2001).

Some researchers argue that gaining an understanding of false belief represents a conceptual change in the acquisition of domain general metacognitive ability (Perner, 1991, Perner, Mauer, & Hildenbrand, 2011). However, an alternative view suggests that theory of mind is a socially specific metacognitive ability (Leslie, 2005; Onishi & Baillargeon, 2005), albeit it may lead to or facilitate more general aspects of metacognition (Lockl & Schneider, 2007; Ricketts et al., 2013).

Independent of these views, recent research has begun to consider the consequences of gaining a theory of mind and how early achievement in this ability may affect later cognitive abilities beyond the social domain (Astington,

2001; Lecce, Bianco, Demicheli, & Cavallini, 2014; Lockl & Schneider, 2007). Lockl and Schneider (2007) demonstrated that children who gained a theory of mind early performed better in meta-memory tasks one to two years later. They suggest that theory of mind may go beyond the ability to predict and explain actions and action outcomes in the social domain, to influence cognitive processing across domains. This view is consistent with earlier research (see 1.3.3) that found that children's knowledge of human intentions and goal-directed behaviour contributed to their overall coherence and understanding of story structure (Stein & Albro, 1997). Furthermore, as noted earlier, a recent study found that measures of theory of mind contributed to reading comprehension over and above language and word reading skills in a sample of adolescents with autism spectrum disorders (Ricketts et al., 2013). If theory of mind is an index of a socially specific metacognitive ability that generalizes *or* an early measure of domain general metacognition, it seems reasonable that early ability may contribute to the development of later reading comprehension skills. However, the investigation of early theory-of-mind ability and its influence on later reading comprehension in a typically developing population remains unexplored.

1.5.2.1 Developing a theory of mind

During preschool years children show a series of changes in their conception of mental representation as they acquire a theory of mind. Evidence suggests that an understanding of desires precedes an understanding of beliefs (Rakoczy, Warneken, & Tomasello, 2007; Wellman & Liu, 2004). Children as young as 18 months show reasoning about desires; they understand that other people may have different desires and therefore different preferences (Repacholi & Gopnik,

1997). At three years old, children are able to demonstrate an understanding of incompatible desires between two people (Rakoczy et al., 2007). Three year olds also show an understanding of diverse beliefs; they are able to reason that they and another person can have a different belief about the same situation, providing they do not know which belief is true or false (Rakoczy et al., 2007). However, a wealth of evidence suggests that understanding false belief is more complex (Wellman et al., 2001; Wellman & Liu, 2004). When completing false belief tasks, (for example, an unexpected location task where an object has been moved to a new location unbeknown to the story character) three year-olds will tend to judge that the story character will search for the object in its new location. Four and five year olds will correctly judge that the character will look for the object where he/she mistakenly believes it to still be (Wellman & Liu, 2004).

Two theoretical positions have evolved to provide alternative explanations. One position suggests that very young children have an innate understanding of mental states, but they are not successful in traditional theory-of-mind tasks because they lack necessary general language and cognitive skills (Leslie, 2005). The other position suggests a conceptual developmental hypothesis, where children's explicit understanding of mental states develops with age (Perner, 1991). This shift in understanding is clearly represented in research when, around the age of four, children's successful performance in false belief tasks moves from below to above chance (Perner, 1991; Wellman, 1991).

Researchers supporting the former position dispute the conceptual change theory and propose that the milestone around four years of age results from gaining the skills and ability to deploy an innate, modular understanding of mental states

(Leslie, 2005; Onishi & Baillargeon, 2005). This account argues that young infants are able to pass spontaneous, implicit false belief tasks (measured using a looking time paradigm), but explicit false tasks require children to access high levels of cognitive ability, particularly executive function and language skills, to elicit a response. The modular accounts of theory of mind propose that understanding and imputing mental states remain a socially specific ability.

Researchers supporting the broader, domain general view, propose that children's theory of mind develops as a conceptual change (Perner, 1991). They argue that young infants show an implicit understanding of behavioural rather than mental states, and implicit understanding develops into explicit understanding around the age of four years. This development requires language skills to make it verbally accessible. Within the conceptual change theory there are two accounts of how children use this ability. The first is the 'theory theory' (Gopnik & Welman, 1994; Perner, 1994), which suggests that children use a science-like theory to evaluate a proposition within its context to judge whether it is true. The second is the Simulation Theory (Harris, 1992), which proposes that children are able to introspect on their own beliefs and imagine a different stance from another's mind. Perner (1991) suggests that this development is the result of a conceptual change of how knowledge is constructed.

Perner and colleagues propose that young infants have a single updating model of the world, where they represent the people and objects in their environment in real time and update their representation as things change. From 18 months, children start to represent non-present situations and can entertain other models representing hypothetical situations, such as pretend and desires. These are

known as secondary representations. Children are able to switch between reality and these models, but conceive them to be other terms of reality; they are not aware that they are mental representations. From three to four years old, children begin to understand that these multiple models are representations. They are able to distinguish between models and what they represent or misrepresent. This understanding is meta-representation.

The conceptual change account predicts that four year olds, once they understand mental representation will understand any form of meta-representation, for example, drawings (Doherty & Wimmer, 2005) and language (Perner, Stummer, Sprung, & Doherty, 2002). Perner and colleagues propose that meta-representation is a domain general understanding of perspective, in other words a general understanding that a situation or object can be described and/or acted upon in different ways depending on a person's perspective. A strong association was found between performance in false belief tasks and metalinguistic ability (the ability to reflect on language) suggesting that mental and linguistic representation have a close developmental link (Perner et al., 2002). The authors propose that the ability to judge between two different perspectives underpins success at both tasks. In their naming task, they suggest that children needed to keep both options in mind whilst they judged which description, of the same object, that one of two characters had used. In a false belief task the authors propose that a child uses the same ability to integrate the 'real' location and 'believed' location in a single representation, but then considers them as two perspectives when judging where the protagonist will search. In line with a Piagetian view, this domain general account would suggest that passing false belief tasks represent a 'watershed' in children's meta-representational ability.

1.5.2.2 Theory of mind and reading comprehension

In addition to the potential metacognitive link between theory of mind and reading comprehension, the socially specific implications (i.e., socially orientated to social agents with minds) might directly contribute to reading comprehension. An understanding of the mental states of others is a fundamental necessity when reading for meaning. Text represents the beliefs, knowledge, intentions, and possibly desires, of others as dictated by the author, and these may be different to those of the reader. An understanding of others' thoughts, knowledge and feelings is crucial for effective and competent oral and written communication (Doherty, 2009).

Further to the evidence reported by Ricketts et al. (2013), linking theory of mind and reading comprehension in a sample of adolescents with autism spectrum disorders, other research has considered the relationship between theory of mind and meta-knowledge *about* reading (Lecce, Zocchi, Pagnin, Palladino, & Taumoepeau, 2010), theory of mind and the understanding of the thoughts and actions of characters in story narratives (Pelletier & Astington, 2004) and theory of mind and meta-memory (Lockl & Schneider, 2007). These studies are discussed further in Chapter 5. Additionally, there is a vast body of research investigating the relationship between theory of mind and language (see Milligan, Astington, & Dack, 2007 for meta-analysis) and executive function (e.g., Carlson & Moses, 2001; Carlson, Mandell, & Williams, 2004). However, the relationship between reading comprehension and theory of mind, specifically *early* theory of mind, is unexplored. Reading comprehension and theory of mind share correlates that support and scaffold ability; particularly language and executive function skills and it may be that that be that these variables mediate any relationship

between the two abilities. Nevertheless, it is important to determine the degree to which they are linked, as theory of mind, as a measure of social specific understanding or as an index of more general metacognitive ability, might be a potential early predictor of later reading comprehension performance.

1.5.3 The role of environmental and social factors

Evidence has clearly established that reading acquisition is not an isolated stage of development that is initiated when children begin formal literacy instruction within the educational system. The emergent literacy perspective (Clay, 1966, Teale & Sulzby, 1986) conceptualizes the acquisition of reading as part of a continuum from pre-reading to reading, originating in infancy as children begin to understand language, and developing through preschool years as they are exposed to print within their social environment (Whitehurst & Lonigan, 1998). The following section initially considers the role of exposure to print and then subsequently discusses the broader concept of the home literacy environment.

1.5.3.1 Exposure to print

Knowledge of print concepts (Davidse, de Jong, Bus, Huijbregts, & Swaab, 2011) has been found to predict concurrent and subsequent word reading skills. However, other studies have found no unique predictive relationship between print knowledge and later emergent literacy skills or later reading skills (Lonigan et al., 2000). In other words, environmental print knowledge was associated with later literacy measures when considered in isolation; it was not a unique predictor after controlling for letter knowledge and PA. As letter knowledge and

PA predicted print knowledge, Lonigan et al. (2000) argue that print knowledge may be considered a proxy measure for early literacy knowledge and may reflect exposure to print *plus* other literacy-related activities.

There is little evidence to suggest that parents use shared reading experiences to teach children about orthographical features of print. Eye-tracking investigations have shown that children seldom fixate on print and tend to focus on pictures during shared reading (Evans & Saint-Aubin, 2005). In general, it appears that parents consider storybook reading as an opportunity to enrich their children's comprehension and vocabulary, rather than teach decoding skills and print awareness. However, individual differences in the short time that children do fixate on the print are predicted by children's decoding skills, suggesting that perhaps they are motivated to do so (Evans, Williamson, & Pursoo, 2008).

Intervention studies introducing print referencing strategies, which train adults to use verbal and non-verbal cues, such as tracking the text with a finger during shared reading, appear to facilitate children's attention to the print (Justice & Ezell, 2004; Justice, Pullen, & Pence, 2008). As a result, children show enhanced print concepts and letter knowledge, but not oral language. In a sample of low SES preschoolers who received print referencing intervention, the benefits endured and they showed better word reading and reading comprehension two years later (Piasta, Justice, McGinty, & Kaderavek, 2012). This is a promising area of research, as strategies are easy to introduce, in both educational and home settings, and as discussed in the following section shared storybook reading is the most salient aspect of the home literacy environment.

1.5.3.2 Home Literacy Environment

The view that children gain educational and social advantages from parent-child shared storybook reading at home has been incorporated within the educational policies of western societies (Scarborough & Dobrich, 1994). The *home literacy environment* (HLE) is an umbrella term used to reference parent-child shared book reading plus a collection of other literacy-related resources and practices that young children experience in the home, especially during the preschool years (Bus, van Ijzendoorn, & Pellegrini, 1995). It covers a wide range of variables that may influence children's reading acquisition and development, including frequency and quality of shared reading, the availability of printed materials in the home, parental modelling of literacy activities, and direct parental teaching of letters and words. To date, the majority of HLE research has examined the influence of parent-child shared book reading and less has focused on direct parental teaching (Martini & Sénéchal, 2012; Sénéchal, 2006).

1.5.3.2.1 Socioeconomic status and HLE

The link between family socioeconomic status (SES) and children's reading ability has been well established, with low family SES highlighted as a risk factor for poor achievement in reading (e.g., Bracken & Fischel, 2008; Chaney, 1994; Fish & Pinkerman, 2003; Phillips & Lonigan, 2005). Other researchers have examined the relationship between SES and HLE (e.g., Hartas, 2011; van Steensel, 2006). The relationship between home literacy activities (measured as frequency of shared story reading and visits to the library) and children's cognitive abilities at three years old (concepts of letters, colours, numbers, sizes, shapes and objects) were examined as part of an extensive project tracking the development of

approximately 19,000 children, born in the UK during 2000 to 2001, in relation to their families' SES (Kiernan & Huerta, 2008). Structural equation modelling showed that children's cognitive skills were partially explained by the HLE measure. However, the data revealed that the relationship between children's cognitive ability and HLE was not influenced by SES status, suggesting that there is variation in the degree of HLE practices across all SES groups. Support for this conclusion has been found in several smaller studies examining the influence of HLE practices across a range of SES groups (e.g., Chaney, 1994; Sénéchal, 2006; Smith & Dixon, 1995). Further research has examined the role of HLE within homogenous SES groups (Payne, Whitehurst, & Angell, 1994). Payne et al. (1994) investigated the effects of HLE on oral language skills within a sample of four year olds from low SES families. They found that HLE explained 12% unique variance in the children's receptive and expressive language scores, after controlling for primary caregiver IQ and education level, suggesting that rich home literacy experiences contribute to language development over and above SES factors. The HLE, as measured by shared reading and library visits, may play a role in moderating the risk posed by low SES for children's literacy and language development (Kiernan & Huerta, 2008).

1.5.3.2.2 The influence of HLE activities

A meta-analysis examining the frequency of parent-child shared reading as a predictor of children's language and literacy development found that shared reading predicted approximately 10 to 12% of unique variance in children's language skills and 8% of unique variance in children's decoding skills (Mol & Bus, 2011). Other research has consistently supported the relationship between

parent-child shared reading and receptive language (Frijters, Barron, & Bruello, 2000; Hood, Conlon, & Andrews, 2008; Sénéchal, 2006; Sénéchal & LeFevre, 2002). However, many other recent studies have failed to find a direct relationship between shared book reading and letter knowledge (Evans, Shaw, & Bell, 2000; Frijters et al., 2000; Hood et al., 2008; Sénéchal & LeFevre, 2002).

In addition to examining the benefits of parent-child shared book reading, more recent research has demonstrated that exposure to other literacy related practices in the home environment promotes children's later language and reading skills at school (de Jong & Leseman, 2001; Hood et al., 2008; Sénéchal & Young, 2008). Sénéchal and colleagues conducted a longitudinal study examining the influences of parent-child HLE activities in kindergarten (aged 5 years) to children's later emergent literacy in Grade 1 (aged 6 years) and reading ability in Grade 3 (aged 8 years). They found evidence that there are two distinct types of literacy practices at home, which they named '*informal*' and '*formal*'. Informal practices relate to parent-child shared book reading and formal practice involve direct parental teaching about reading and writing. Similarly to the SVR, informal and formal HLE practices appear to form distinct dimensions, with informal practices relating to oral language skills and formal practices relating to decoding skills (Sénéchal & LeFevre, 2002). Additionally, Sénéchal and colleagues (Martini & Sénéchal, 2012; Sénéchal, 2006; Sénéchal & LeFevre, 2002) argue that evidence from numerous studies examining early home literacy experiences suggest that the practices of shared storybook reading and direct literacy instruction are dissociated. In other words, it may not be the same families that value frequent shared book reading that engage in the greatest frequency of direct literacy instruction.

Bus et al. (1995) reported that effect size for the relationship between shared reading and children's literacy outcomes was larger with younger children, suggesting that the HLE may be most influential before children start school and that it may become less significant once children begin formal education. Recent research has provided further evidence to support this view (Hood et al., 2008; Sénéchal & LeFevre, 2002). Other studies found that parental teaching also changes over time, as parents adjust their teaching to their children's skill levels once they have begun formal schooling (Sénéchal & LeFevre, 2014; Silinskas, Leppänen, Aunola, Parrila, & Nurmi, 2010). Less is understood about the effects of HLE activities, particularly parental teaching, on children's cognitive abilities at the very beginning of school. In order to advise parents of best practices to prepare their children for the start of formal education, it is crucial, therefore, to gain an understanding of the influence of HLE practices on children's early cognitive skills before they begin school.

1.5.3.2.3 The Home Literacy Model

As a result of their research Sénéchal and LeFevre (2002) proposed the Home Literacy Model (Figure 1.3) to describe the pathways from home literacy practices to later reading comprehension. According to the model, there are direct pathways from home literacy practices to language and emergent literacy ability at the very beginning of formal education. After the start of schooling, the pathways to reading at the end of Grade 3 become indirect.

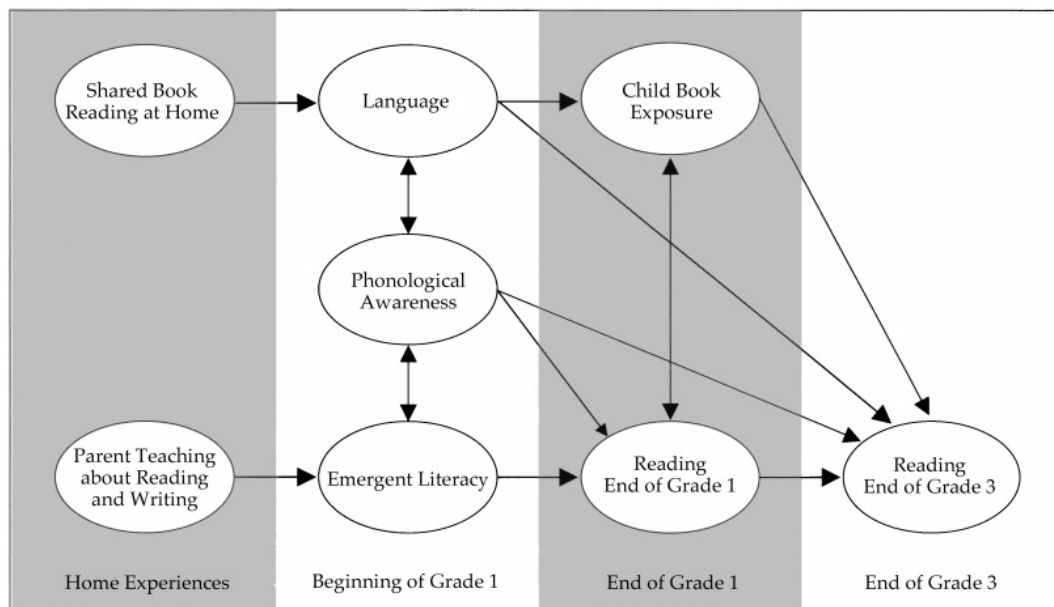


Figure 1.3. The Home Literacy Model (Sénéchal & LeFevre, 2002)

At the beginning of Grade 1 oral language is predicted by the ‘*informal*’ practice of shared reading at home. In contrast, the ‘*formal*’ aspect of direct instruction predicts emergent literacy skills (letter and word knowledge). Both language and emergent literacy relate (bi-directionally) to PA, mediating the relationship between HLE and PA. After children begin school, early emergent literacy skills and PA predict reading ability at the end of Grade 1, when decoding is the focus for reading. Early reading skills at this stage subsequently predict more efficient reading skills at the end of Grade 3. In contrast, oral language skills do not directly predict early reading skills (although there is an indirect pathway via children’s book exposure). However, early oral language does directly (and indirectly via children’s book exposure) predict reading at the end of Grade 3, when word reading is more efficient and comprehension skills become more crucial.

Sénéchal (2006) demonstrated further support for the model within a sample of French-speaking Canadian children. The two HLE practices were once again independent. Shared reading related to children’s vocabulary in Grade 1, which

mediated the relationship between HLE and reading comprehension in Grade 4. Consistent with previous studies, direct instruction predicted early decoding skills at the beginning of Grade 1, which subsequently contributed to reading efficiency and fluency in Grade 4. However, in contrast to previous studies, Sénéchal (2006) also reported a direct pathway (accounting for 3% of unique variance) from parental direct instruction to word reading at the end of Grade 1. As in previous studies, the relationship between HLE and PA was mediated by oral language and decoding skills.

1.5.3.2.4 HLE and emergent literacy

Research has consistently found that early storybook exposure significantly contributes to children's vocabulary knowledge (Farrant & Zubrich, 2013; Hammer, Farkas, & MacZuga, 2010; Sénéchal, LeFevre, Hudson, & Lawson, 1996). Links with other language skills are less clear. Past research has indicated that the effects of storybook exposure may be most strongly related to children's language comprehension (DeBaryshe, 1993). However, contrasting results were found in a more recent study (Sénéchal, Pagan, Lever, & Ouellette, 2008). Sénéchal et al. (2008) examined the effects of shared storybook reading and broader language and narrative skills. They found that storybook exposure was a unique predictor of expressive vocabulary, but, surprisingly, not children's narrative skills. The inconsistent results in the research may be due to varying measures and different age groups employed in the studies and further research is essential to determine how HLE practices influence early oral language skills, particularly through the first years of school, when HLE activities have their greatest impact (Bus et al., 1995). This thesis examined the role of the preschool HLE in early preschool

vocabulary and in later listening comprehension at five years to extend current knowledge of the early influences of the HLE.

Beyond vocabulary and oral language skills, other researchers have suggested that the storybook exposure aspect of HLE may influence other aspects of children's emergent literacy. Mol and Bus (2011) argued that experience and familiarization of the conventions of storybooks might foster print awareness that may subsequently nurture children's motivation to read and, as such, have long-term implications. However, research has linked the development of print concepts to direct literacy instruction at home, rather than shared storybook reading alone (Levy, Gong, Hessels, Evans, & Jared, 2006). The relationship between storybook exposure and phonological awareness (PA) is also unclear. As previously noted (see section 1.4.1.3) PA has a significant reciprocal relationship with oral language skills; however, studies investigating HLE have found no significant correlation between HLE measures and PA (Hood et al., 2008; Sénéchal & LeFevre, 2002).

Several studies, having measured the frequency with which parents explicitly teach their children about letters and words, have highlighted a relationship between this dimension of HLE and letter sound knowledge (Evans et al., 2000; Hood et al., 2008; Sénéchal & LeFevre, 2002; Sénéchal, LeFevre, Thomas, & Daley, 1998). The literature has produced clear evidence that storybook exposure alone is not sufficient to support the development of orthographic skills. A recent Canadian study examined the nature of direct instruction in more detail (Martini & Sénéchal, 2012). They found, in a predominantly middle class sample, that parents reported that they engaged 'often' or 'very often' in direct literacy

instruction with their five-year-old children. Parents reported that they used a variety of contexts and print forms as teaching tools, including storybooks, alphabet books, and environmental posters and shopping lists. From the analyses, the authors reported that the parent-report questionnaire items had loaded onto two factors. The first was teaching the alphabet and the second was teaching reading; however it was only the latter of the two factors that uniquely predicted children's emergent literacy.

In their longitudinal study, Sénéchal and LeFevre (2002) assessed the reading ability of the children in their sample at the end of Grade 3 (8 to 9 years old). Based on the two preschool HLE measures (storybook exposure and direct literacy instruction), the children were divided into four groups. The authors reported that children who had experienced high levels of shared reading and direct instruction at home during preschool years performed better than their peers at the beginning of Grade 1, before they experienced formal literacy instruction, and continued to read well in Grade 3. In contrast, those children who had experienced little of either HLE practice in the preschool years performed worse at both time points. Children who had experienced high levels of instruction, but lower levels of shared reading performed well in reading assessments at the beginning of Grade 1; however, they appeared to have lost their advantage by the end of Grade 3. Conversely, children who had greater storybook exposure with lower levels of direct instruction read less well in Grade 1, but had caught up with the children who had experienced high levels of both HLE practices by the end of Grade 3. These results suggest that early efforts to teach decoding skills has a direct impact on children's emergent reading skills before they begin formal literacy instruction, but unless supported by frequent

exposure to storybooks and shared reading the advantage does not last through the early years of education.

Research over the past decade, particularly the work of Sénéchal and colleagues, has clarified the contribution of children's early literacy experiences in the home to their subsequent reading development. It is clear that parent-child shared reading of storybooks and more 'formal' direct teaching of letters and words both influence the development of children's reading ability through the early years at school. Other studies have also investigated children's interest in HLE practices (typically measured as children's interest in reading) suggesting that the degree of interest by the child may affect the frequency of home literacy activities (Hood et al, 2008; Martini & Sénéchal, 2012; Sénéchal et al., 1996). Results from these studies have been mixed; however, evidence has been found to suggest that children's interest in HLE activities does significantly contribute to vocabulary (Sénéchal et al., 1996), letter knowledge (Frijters et al., 2000) and emergent reading (Martini & Sénéchal, 2012).

Overall, it appears that early HLE experiences provide a foundation that nurtures children's reading skills and, importantly, their motivation to read (Baroody & Diamond, 2012; Martini & Sénéchal, 2012; Sénéchal & LeFevre 2002). Children's continued success at reading may then result from a "Matthew effect" (Stanovich, 1986), such that their early achievement will foster subsequent achievement through more exposure to print, acquiring more vocabulary and develop stronger reading skills. Although it may also be fair to assume that parents who have provided a rich HLE during the preschool years will continue to do so through primary education and beyond (Sénéchal & LeFevre, 2014). However, the impact

of HLE activities on the development of children's pre-reading cognitive skills before the start of preschool remains relatively unexplored, particularly the influence of direct literacy-related teaching by parents. It is crucial to understand the impact of HLE activities on children's cognitive abilities at this time, when the influence of HLE activities may be at their greatest, to guide the development of effective and salient strategies to help parents prepare their children for the start of formal education.

1.6 Summary

Reading comprehension is a multifaceted, complex process, underpinned by a multitude of factors that contribute varying and changing degrees of influence through the acquisition and development of comprehension skills. The Simple View of Reading (SVR; Gough & Tunmer, 1986; Hoover & Gough, 1990) proposes that reading comprehension is the product of fluent word identification and linguistic comprehension and each dimension is underpinned by a different set of skills. Generally, research has supported the SVR, both in the critical roles of each dimension and their independence from each other. However, research with beginner readers has argued that the two dimensions are more strongly correlated in the early development of reading, and vocabulary, in particular, links oral language skills to word reading skills. There has been much less research examining the fit of the SVR model during the early development of the cognitive precursors of reading comprehension. There is a need for further research to investigate the origins and early development of precursors of the two domains of the SVR and examine their predictive relationship to the acquisition of reading comprehension. Understanding these early relationships in

pre-reading children may highlight early markers for potential reading comprehension problems and inform the development of early, targeted interventions (Lonigan et al., 2000). The primary aim of this study was to examine the relationship between the precursors of reading comprehension in a typically developing population of three-year-old preschoolers within the framework of the SVR.

The majority of reading comprehension research has focused on the correlates of less skilled performance, specifically in samples of children classified as 'poor comprehenders' during the mid-primary years. Poor comprehenders are children who demonstrate difficulties with reading comprehension, but show adequate decoding skills. Within these groups, the roles of crucial higher-order comprehension processes (e.g., inference making and comprehension monitoring) and executive function skills, particularly working memory, have been explored. These skills have also been investigated in the listening comprehension performance of younger children. However, the influence of executive function in the acquisition of reading comprehension in a typically developing population remains unexplored. Other research has suggested that the SVR is too simple and metacognitive processes, including the higher order comprehension processes should be considered as an additional dimension to the SVR (Kirby & Savage, 2008). Research is needed to investigate the contribution of metacognitive processes to reading comprehension in all populations; however it is particularly crucial for young beginner readers as early metacognitive ability may be a potential indicator of subsequent reading comprehension ability that could be relatively simple to assess in young children. A further aim of the current study was to address this issue through investigation of the relationship between

early theory of mind at three years and the acquisition of reading comprehension at six years.

Recent research has aimed to investigate the early cognitive correlates of poor comprehenders through the examination of retrospective data for children highlighted as poor comprehenders in mid primary school (Nation et al., 2010). Results yielded evidence that poor comprehenders, when compared to a control group matched for age and word reading ability, showed oral language deficits through the early school years. However, children's abilities through the preschool years, or, indeed, the baseline levels of performance at the very beginning of preschool were not examined. Research is needed to extend existing knowledge of the early correlates of poor comprehension to younger preschool children. Additionally, the majority of existing research has not measured children's reading comprehension until they are seven or eight years old; however, Nation et al. (2010) initially assessed reading comprehension at six years and found that the performance of poor comprehenders remained relatively stable through the subsequent years. The implication of this evidence suggests that early identification of poor comprehenders is feasible and, with extended knowledge of the preschool cognitive precursors, would enable the introduction of targeted intervention through the earliest stages of reading comprehension development. The current study aims address this issue by examining the early cognitive profiles of children identified as poor comprehenders at the age of six years.

1.6.1 Overview of the current study

This thesis aims to extend existing knowledge of the early correlates and precursors of reading comprehension to a younger, typically developing UK population. Past research investigating early reading comprehension has aimed to identify and profile children who have successfully mastered decoding and word identification skills, but struggle to comprehend what they read. However, establishing causality remains a problem with this approach, as any deficits identified within the skills deemed to underpin successful reading comprehension may exist as a consequence of poor comprehension. To investigate causal links it is crucial to examine the skills linked to reading in very young children before they learn to read. The current research project aimed to address this issue by initially assessing very young children in their first year of nursery education before they began any formal literacy instruction and following their progress to the acquisition of reading comprehension at six years old. There is, to date, limited research exploring the relationships between these skills and emergent reading comprehension in such young children.

In the UK, children begin half-day nursery education at three to four years old. Full time education begins at four to five years old, including the introduction of formal literacy instruction, which is typically younger than other countries. In the current study, children were all non-readers and spoke English as their main language. They were initially assessed at three to four years old on a wide range of cognitive and socio-cognitive measures (see section 2.5 for details of measures) during their second term in preschool nursery. In addition, parents completed a questionnaire about children's home literacy environment. Children were reassessed one year later, in the second term of their reception year and again at

the end of the reception year, following a year of formal literacy instruction. Subsequently, children completed a final assessment, at the end of Year 1, at which time their reading comprehension was assessed.

This thesis focuses on the early skills underpinning the acquisition of reading comprehension, using the SVR framework. It initially reports an investigation of the influence of the preschool home literacy environment on children's early cognitive skills at the start of their nursery education, before they experienced formal literacy instruction (Chapter 3). Subsequently, the thesis reports an evaluation of the correlational and predictive relationships between these early cognitive skills and the development of decoding-related and oral language skills, within the framework of the SVR, ultimately examining their relationship with an early measure of reading comprehension at six years old (Chapter 4). Next, it reports a study that further extends existing knowledge of the acquisition of reading comprehension through investigation of a novel factor in this field of research, theory of mind, to determine whether this measure of metacognition uniquely contributed to reading comprehension over and above the two dimensions of the SVR (Chapter 5). Finally, in light of the SVR, and as the study examined a sample of typically developing children, it would be expected that variability will be found in reading comprehension performance at six years old. The thesis, therefore, identifies and reports retrospective cognitive and socio-cognitive performance for good, average and poor comprehenders, with the aim of identifying potential early indicators for strong and weak reading comprehension ability. The identification of early indicators will expand current knowledge of emergent literacy and reading comprehension acquisition and

inform the development of interventions designed to help children at risk for developing later reading comprehension difficulties.

1.6.2 Summary of aims of current research

1.6.2.1 Home Literacy Environment (HLE) (Chapter 3)

The first aim of the thesis was to extend existing knowledge of the early relationships between HLE practices and emergent literacy skills by determining whether children's HLE experiences at three years old predicted baseline measures of the pre-reading skills at the beginning of preschool. Specifically, the aim was to extend the Home Literacy Model (Sénéchal & LeFevre, 2002) to a younger population by examining the longitudinal relationships between preschool HLE practices and children's emergent literacy (single word reading and listening comprehension) at five years old, following a year of formal literacy instruction.

1.6.2.2 Cognitive precursors of reading comprehension (Chapter 4)

The second aim was to add to existing knowledge of the precursors of reading through examination of preschool cognitive factors (code-related factors, oral language and executive function) within the framework of the Simple View of Reading (SVR; Gough & Tunmer, 1986; Hoover & Gough, 1990). Specifically, the aim was to examine the stability of relationships between factors across the early years and predictive relationships to an early measure of reading comprehension at the end of Year 1.

1.6.2.3 Theory of mind and reading comprehension (Chapter 5)

The third aim was to examine the potential role of a novel factor (theory of mind) in the field of research investigating early reading comprehension in typically developing populations. The study investigated the longitudinal and concurrent relationship between theory of mind (measured at three, four and six years) and the acquisition of reading comprehension at six years old. Specifically, the aim was to determine whether early theory-of-mind ability in preschool children uniquely contributes to later emergent reading comprehension at the end of Year 1, over and above the word reading and linguistic comprehension components of the SVR.

1.6.2.4 Comprehender profiles (Chapter 6)

The aim of the final study was to add to and extend the limited research that has investigated the early cognitive profiles of children with poor reading comprehension in the absence of word reading difficulties. Specifically, this current study aimed to identify groups of poor, average and good comprehenders, based on reading comprehension performance at six years old, and use retrospective data to compare early cognitive and socio-cognitive profiles.

Chapter 2 Methodology

2.1 Overview

Children in the current study completed an extensive range of cognitive and social-cognitive tasks at each time point through the three-year longitudinal study. The aim of this chapter is to provide clarification of the design and ethical issues of the overall study. It will also discuss descriptive information about participants and specify, in detail, the materials and procedures used in the studies reported in this thesis. For brevity, the following experimental chapters will only provide a recap of tasks and appropriate references to this chapter. The current study was part of a larger research project investigating children's early acquisition of reading. This thesis will focus on the investigation of skills underpinning the acquisition of reading comprehension.

2.2 Study design

To account for cognitive deficits that may occur as a result of reading problems, it was crucial to begin the study with a sample of non-readers, before the beginning of any formal literacy instruction. The longitudinal design allowed for children's progress to be monitored as they completed their preschool year and the first two years of fulltime education. The study was a correlational design; however the longitudinal aspect of the study allowed for stronger inferences about causal relations between early cognitive and socio-cognitive skills and later reading ability to be highlighted. The aim was to determine unique contribution of early skills to later reading comprehension, through examination of direct and indirect

pathways after controlling for earlier ability and baseline measures. Two cohorts ($N = 43$ and 55) of three to four year-old children were recruited from the nursery departments of two primary schools in Kingston-upon-Thames, UK. Each cohort consisted of children from both schools. The cohorts were recruited one year apart to ease the demands of data collection.

2.3 Ethical issues

This study was approved by the University of Roehampton Ethics Committee (ref: PSYC 09/043; PSYC 11/025). Schools, which had been previously participated in literacy research conducted by the university, were contacted and invited to take part. Additionally, other primary schools in the same area, Kingston upon Thames, were contacted. Contact was initially made via letter and this was followed up with a telephone call. Two schools expressed an interest in the study and requested further information. More detailed information about the study was presented at meetings with head teachers and classroom staff at the schools. Both schools confirmed their participation and letters were sent home to parents of the new intake of children to the nursery year.

Three levels of consent were obtained for this study: Head Teacher, parental and child. Head teachers confirmed their school's participation through signed consent (see Appendix 1). At the request of the schools, letters to parents detailed information about the study and included an 'opt-out' consent form (see Appendix 2). Parents were asked to respond if they did not want their children to take part in the study. Verbal consent was obtained from children at the beginning of each assessment session. Children whose parents requested that

they did not participate were not included in the study. Participants were selected from the remaining sample to reflect an equal numbers of girls and boys, children attending morning and afternoon nursery sessions, and age range. Parents of children in the sample were then sent further information about the study and asked to complete the home literacy environment questionnaire (see section 2.5.2.8.3 for details). This procedure was repeated the following year when recruiting the second cohort.

Following the initial recruitment procedure, parents were kept informed about the progress of the study with a letter at the beginning of each new academic year (e.g., Appendix 3). At each time, they were advised of their right to withdraw their child from the study. At each testing session, researchers liaised with classroom teachers to ensure that children were happy to take part in the sessions. During sessions, children were monitored and if, on very seldom occasions, it appeared that they were reluctant to continue, the session was abandoned and children were given the opportunity to complete the tasks at an alternative session. Children were given the opportunity to talk or ask questions at the end of each session. A final written debrief will be given to parents and schools at the end of the larger research project.

2.4 Participants

The initial sample comprised of 98 preschool children (51 boys and 47 girls; mean age 3:10 years, $SD = 3.7$ months) attending the nursery year of two mainstream primary schools in North Kingston upon Thames, Surrey, in South East England. Both schools are located within and serve a predominantly middle-

class population. Ofsted (2013) reports that both schools are relatively large (556 and 499 pupils) and have excellent attendance rates of 97%. Both schools have a very low percentage of pupils qualifying for free school meals (7.7% and 8.7%). The majority of the children came from well-educated families: 88% of parents had attained level four or above (i.e., completed a higher education award) in the National Qualifications Framework (NQF). This percentage was considerably higher than the regional reported level of 42% (Office for National Statistics, 2012). All children spoke English as their main language. As mentioned above, the children were recruited in two cohorts, one year apart, during their second term at nursery. The first term of the nursery year is considered a 'settling in' period and the children began school at various stages throughout the term; therefore, participants were initially assessed during the second term.

By the beginning of the second term all the children attended school for five three-hour sessions per week (52 attended morning sessions; 46 attended afternoon sessions). There was no formal literacy instruction given during this educational year; however the children experienced games to promote phonological awareness and were read to often. Formal literacy instruction was introduced the following year, when the children began full time compulsory education (Reception). Children completed two assessment sessions during their Reception year and a final assessment at the end of Year 1. Table 2.1 shows the children's mean age at each time point.

Table 2.1: *Children's age (yrs: mths) at assessment points (Nursery, Reception and Year 1)*

	Nursery	Reception	Reception	Year 1
	Spring term	Spring term	End of year	End of year
<i>N</i>	98	84	83	80
Mean age (<i>SD</i>)	3:10 (3.73)	4:10 (3.82)	5:02 (3.84)	6:03 (3.89)
Age range (months)	40 - 54	52 - 65	56 - 69	69 - 81

The attrition rate from Nursery to Reception was 14% and 4% from Reception to the end of Year 1. The attrition rate compares favourably to other similar longitudinal studies, which have reported attrition rates of over 26% (Hood, Conlon, & Andrews, 2008). A total of 80 children (39 girls; 41 boys) were available for retesting at the end of Year 1. Analysis of key baseline variables revealed that there were no significant differences between the performances of the children who remained at the participating schools compared to those children who left during the study. Means and group differences for key baseline variables, measured at the first time point (T1), are reported in Table 2.2, along with statistics for independent *t*-tests. Using *Levene's Test for Equality of Variance*, homogeneity of variance was assumed in all cases.

Table 2.2: Means, standard deviations and group differences for key T1 variables between children who completed the study and children who left the schools during the study

	Remaining students <i>N</i> = 80	Leavers <i>N</i> = 18	Group differences
Age control	45.11 (3.84)	45.44 (3.41)	$t(96) = .34$, ns
Non-verbal ability	12.08 (3.05)	12.33 (3.19)	$t(96) = .31$, ns
Verbal ability	47.19 (10.27)	48.06 (10.70)	$t(96) = .32$, ns
Letter knowledge	7.15 (7.44)	10.61 (8.97)	$t(96) = 1.72$, ns
PA	10.76 (5.79)	13.33 (4.91)	$t(96) = 1.75$, ns
Print knowledge	5.74 (2.69)	6.00 (2.32)	$t(96) = .38$, ns

Note: Age control = children's age at 01/01/2010 for Cohort 1 and at 01/01/2011 for Cohort 2; PA = phonological awareness composite

As can be seen, there were no statistical differences on the key baseline measures between those children who remained at the school and those who left. However, it must be noted that the somewhat smaller sample size of the leaver group may limit the power to detect the difference.

2.5 Materials and Procedure

2.5.1 General procedural issues

One of the main challenges of the study was to find age-appropriate tasks for these very young children. Children's development over the early school years demanded that assessment tasks were carefully reviewed for each time point to avoid potential floor and ceiling effects. Consequently, it was sometimes necessary to use different assessments tasks at each time point to measure the same construct across the study. Assessment sessions were restricted to a maximum of 20 minutes and children were tested individually in a quiet area outside of their classroom. To avoid order

effects, the sessions were fully counterbalanced, both within the session itself and in the order with which the children completed the sessions.

Group data were explored at each time point, using a multivariate analysis of variance (MANOVA) on key variables, to confirm that there were no order effects. Results are reported below at each time point (see section 2.5.2 for T1, section 2.5.3 for T2, section 2.5.4 for T3 and section 2.5.5 for T4). Sessions always consisted of a variety of activities to encourage children's focused attention and reduce fatigue. After each testing session children were rewarded with their choice of 'smiley face' sticker.

The research reported in this thesis was conducted as part of a wider research project and over the three-year study there were additional assessment time points that are not included in this thesis. Additionally, at those time points that are included in the thesis, there were some extra assessment tasks administered, which are not included in the experimental studies reported. Table 2.3 shows all assessment tasks administered at the four time points reported in this thesis and indicates the tasks not included in the current studies. All other tasks are described in detail in the following sections.

Table 2.3: Assessment tasks administered in Nursery (T1), Reception (T2, T3) and Year 1 (T4)

Construct	Measure	T1 N	T2 R	T3 R	T4 Y1
Behaviour*	Parent report CBQ ¹	X			
	Teacher report SDQ ²				X
HLE	Parental report questionnaire	X			
	Title Recognition Task (TRT)	X			
Nonverbal Ability	Block design (WPPSI-III ³)	X			
Letter Knowledge	Letter naming (PAT ⁴)	X	X		
Word Reading	Single word reading (BAS ⁵)	X	X		
	Single word reading (YARC ⁶)			X	
Reading Efficiency	TOWRE ⁷				X
Reading Comprehension	YARC				X
Phonological Awareness	Rhyme detection (PAT)	X	X		
	Word completion (PAT)	X	X		
	Sound matching (CTOPP ⁸)			X	
	Elision (CTOPP)			X	X
	Blending (CTOPP)				X
Phonological Memory	Non-word repetition (CTOPP)			X	X
Print Knowledge	Print knowledge (TOPEL ⁹)	X	X		
Oral Language	BPVS-II ¹⁰	X			X
	Definitional Vocabulary (TOPEL)		X		
	Linguistic concepts (CELF ¹¹)	X			
	Recalling sentences (CELF)	X			
	Narrative retell (Bus Story)		X		
	Listening comprehension (NARA ¹²)			X	
	Narrative comprehension (Robot)				X
Working Memory	Reverse word span	X	X		
	Cat & mouse task	X			
	Sentence span task				X
	Digit WM task				X
Attention Shift	Card sorting task	X			
Cognitive Inhibition	Day/night task	X			
	Wack-a-mole (go-no-go task)		X		
	Luria's hand game		X		
	Colour/object switch				X
Theory of Mind	Unexpected transfer task	X			
	Unexpected contents task	X			
	'Nasty surprise' task		X		
	2 nd order task		X		
	Strange stories				X
RAN*	Object naming (short form)	X	X		
	Colour naming (short form)	X	X		
	Object naming (CTOPP)			X	X
	Colour naming (CTOPP)			X	X
Visual Processing*	Monster letter tasks ¹³	X			
	Monster non-letter task ¹³	X			
	Same/difference task ¹³	X	X		X
Processing Speed*	Simple reaction task ¹³	X			

Notes: * Not included in thesis; T1 = Time 1; T2 = Time 2; T3 = Time 3; T4 = Time 4; N = Nursery; R = Reception; Y1 = Year 1; HLE = Home Literacy Environment; RAN = Rapid Automatized Naming; 1 = Children's Behaviour Questionnaire (very short form) (Putnam & Rothbart, 2006); 2 = Strengths and Difficulties Questionnaire (Goodman, 1994); 3 = Wechsler Preschool and Primary Scale of Intelligence – Third Edition (Wechsler, 2002); 4 = Phonological Abilities Test (Muter, Hulme & Snowling, 1997); 5 = British Ability Scales (Elliot, Murray & Pearson, 1983); 6 = York Assessment of Reading Comprehension (Snowling et al., 2011); 7 = Test of Word Reading Efficiency (Torgesen, Wagner & Rashotte, 1999); 8 = Comprehensive Test of Phonological Processing (Wagner, Torgesen & Rashotte, 1999); 9 = Test of Preschool Early Literacy (Lonigan, Wagner, Torgesen & Rashotte, 2007); 10 = British Picture Vocabulary Scale: 2nd Edition (Dunn, Dunn, Whetton & Burley (1997); 11 = Clinical Evaluation of Language Fundamentals – Preschool Second Edition (Wiig, Secord & Semel, 2004); 12 = Neale Analysis of Reading Ability (Neale, 1997); 13 = From Stainthorpe, Stuart, Powell, Quinlan & Garwood (2010)

2.5.2 Time point 1 (T1): Nursery spring term (Baseline measures)

Children (mean age = 3:10 years, SD = 3.7 months) initially completed four 15 to 20-minute assessment sessions administered by one of four researchers. Children completed the sessions on different days over a period of five weeks (mean = 21.32 days, SD = 7.17). They were assigned to one of eight groups (four orders of sessions x two order of tasks within sessions) to counterbalance the order of task administration. The effects of counterbalancing were explored by comparing performance between the eight order conditions using a multivariate analysis of variance (MANOVA) on key variables. No significant group differences were found for the omnibus MANOVA, Wilk's $\lambda = .39$, $F(70, 473) = 1.19$, $p > .05$, or for the univariate one-way analysis of variance (ANOVA) for each of the key variables (all $ps > .05$).

In addition to the child assessments, a questionnaire was sent home for parental completion. The questionnaire requested information regarding family structure, social economic status, and the home literacy environment. Assessment materials used at T1, including the parental questionnaire, are detailed below.

2.5.2.1 Nonverbal ability

The Block Design subtest of The Wechsler Preschool and Primary Scale of Intelligence – III (WPPSI-III) (Wechsler, 2002) was used to measure children's non-verbal ability. This task required children to recreate a series of geometric patterns using 3-4 single-coloured blocks (10 items), followed by designs using 2-4 two-toned blocks (10 items). Each item had a time limit of 30, 60 or 90 seconds. Children could have two attempts at the first six items, but only one attempt for

the following 14 items. For the first six items, children were awarded two points if they produced the correct design, within the time limit, at the first attempt or one point for the second attempt. For the following items, children were awarded two points if they produced the correct design within the time limit. Testing was discontinued after errors on three consecutive items. The maximum raw score was 40; however scaled scores (accounting for age) were used in the analyses, with a maximum score of 19.

2.5.2.2 Early Reading Measures

2.5.2.2.1 Single word reading

The single word-reading subtest of the British Ability Scales (Elliott, Murray, & Pearson, 1983) was used at this time point to confirm children as non-readers. The British Ability Scales (BAS) is a battery of individually administered tests of cognitive abilities and educational achievement for school-aged children. The single word-reading subtest requires children to read from a list of 60 words (including regular and irregular words), presented in blocks of ten. The words are initially monosyllabic, common words, presented in a large bold typeface, but become increasing more difficult, and presented in decreasing font size. The test awards one point for each correctly read word. Testing is discontinued after errors on three consecutive items.

At this time, children were shown the first block of ten words, and asked to read out any words that they recognised. Children were reassured that they were not expected to know any words. Scoring zero confirmed that children were non-readers.

2.5.2.2.2 Letter knowledge

The Alphabet Knowledge subtest of the Phonological Abilities Test (PAT; Muter, Hulme, & Snowling, 1997) was used to establish children's letter knowledge. PAT is a standardized test of phonological awareness for children from four to seven years. In this test, children were presented with each letter of the alphabet printed individually on a card, and asked to give the name and/or sound of that letter. Cards were presented in random order. One point was awarded for each correct sound or letter name, giving a maximum score of 26.

2.5.2.3 *Receptive vocabulary*

The children's receptive vocabulary was assessed using the British Picture Vocabulary Scale: 2nd Edition (BPVS-2; Dunn, Dunn, Whetton, & Burley, 1997), a measure of receptive verbal ability in children from preschool to secondary level (3 – 16 years). Children were presented with a series of pages, each showing four separate line drawings. On each trial, the children were asked to select the picture from four options that best illustrated a word spoken by the researcher. Children completed up to seven sets of 12 words (i.e., 84 words). Once a set was started it was always completed even if children made errors. The test was discontinued when children made eight or more errors in a set of twelve words. One point was awarded for each correctly selected picture; therefore the maximum score was 84.

2.5.2.4 *Language skills*

The Clinical Evaluation of Language Fundamentals – Preschool Second Edition (CELF-Preschool-2; Wiig, Secord, & Semel, 2004) is a standardized measure of

receptive and expressive language for preschool and primary school children (3 – 6 years). The test consists of six subtests: three for each of the two aspects of language. As recommended for initial screening and research purposes, the short form of the task was used. The short form consists of one subtest from each set: *Linguistic Concepts* for receptive language and *Recalling Sentences in Context* for expressive language. Both tests show excellent internal consistency, with Cronbach's alphas reported as .85 and .93, respectively.

2.5.2.4.1 Receptive language

In the Linguistic Concepts subtest, children were shown a series of whole page, coloured illustrations showing scenes featuring animals. For each page, the researcher spoke the accompanying instructions, containing linguistic operations, and children were asked to follow directions by pointing at various animal characters as requested (e.g., “*point to the cat and then to the bird.*”). There were 20 test items and one point was awarded for each correct response, giving a maximum of 20 points. The test was discontinued after five consecutive zero scores (errors or no response) for four year olds and four zero scores for five year olds.

2.5.2.4.2 Expressive language

The Recalling Sentences in Context subtest was used as a measure of expressive language. This task evaluated recall and reproduction of spoken sentences in the context of a story. The researcher presented the illustrated storybook, reading the accompanied text (children did not see the text). As the story was read, children were asked to repeat selected dialogue presented in the story. The dialogue

consisted of sentences of increasing length and grammatical complexity. Once again, the test was discontinued following five consecutive zero scores for three year olds and four zero scores for four year olds. Children's responses were recorded verbatim and scored for accuracy. Scores ranged from 0 – 4 per item, depending on number of errors. The maximum score was 52.

2.5.2.5 Phonological awareness

To assess children's phonological awareness, two subtests of the PAT (Muter et al., 1997) were used. In the Rhyme Detection subtest, children were presented with a page showing a central, coloured illustration representing the target word (e.g., cat) and three further, coloured illustrations at the bottom of the page (e.g., fish, gun, hat). The researcher asked the child to select the word that rhymed with the spoken target word (e.g., 'cat') from three choices ('fish', 'gun' or 'hat'). There were 10 test items, giving a maximum score of 10. The test was discontinued after three consecutive errors. Muter et al. (1997) report excellent internal reliability for the task ($\alpha = .87$).

In the Word Completion subtest children were told the first part of a word, which was again illustrated with a coloured drawing, and they were then required to complete the word by supplying the final syllable (in the first eight trials) or phoneme (in the final eight trials). One point was awarded for each correct response giving a maximum total of 16. As before, the test was discontinued after three consecutive errors and children only attempted the phoneme test items if they had successfully completed the syllable trials. Once again, the authors report

excellent internal reliability for both syllable and phoneme trials ($\alpha = .87, .93$ respectively).

2.5.2.6 Executive Function

Four tasks were used to assess different aspects of children's executive function: working memory, cognitive inhibition and cognitive shifting (Carlson, 2005). Two tasks were used to assess children's working memory; one word based task and one digit based task.

2.5.2.6.1 Working memory (Reverse Word Span)

The Reverse Word Span task (Slade & Ruffman, 2005) was used to assess working memory. This task required children to reverse sets of two words and sets of three words orally presented by the researcher. Using a teddy bear prop, the researcher told children that they would play the "backwards game" with Teddy and Teddy would help them learn how to play. Using the toy, the researcher explained that she would say two words, e.g., "*horse – sheep*", and Teddy would say them in a backwards order, e.g., "*sheep – horse*". There was one further training item, followed by two practice items during which the child held the toy, so that "*Teddy could help them*". The test phase included three sets of two words; with feedback given for the first two items and a further three sets of three words, with no further feedback. Scoring awarded one point for correctly reversing two words, two points for correctly reversing three words and a half point was given for reversing two words that were not adjacent. The maximum score was 9.

2.5.2.6.2 Working memory (Cat & Mouse Digit task)

An age-appropriate digit task, based on Keenan (1998) was developed to further assess the children's working memory. The Cat and Mouse Digit Task consisted of a series of counting cards (10cm x 14cm) each showing coloured illustrations of a varying number of cats with double the number of mice, ranging from one cat/two mice to six cats/12 mice (see Appendix 4 for example). The aim of the task was for children to count, retain and then recall the number of cats on each of the cards in the presented series.

Following a practice trial, there were two test conditions. In each condition, cards were presented in a set order and for each there were three trials of two cards and three trials of three cards. However, in one condition the card showing the smallest number of cats was shown last in the series and in the other condition the card with the largest number of cats was shown last. It was thought that showing the card with smallest number of cats last might reduce the cognitive load, as less counting was required. The two conditions were administered during the same assessment session; however there was a filler task between them. The order of conditions was counterbalanced between children. A univariate one-way analysis of variance (ANOVA) confirmed that there was no significant difference between children's scores for the two orders of conditions ($p > .05$).

Initially, children were told that they were going to play a remembering game and do some counting. Children were shown a card with six cats and twelve mice and, after identifying each animal, they were asked to count the number of cats. The researcher then explained to the child that the card would be turned over, but that they should try to remember how many cats they had counted, as they would

be asked again in a few moments. The researcher turned the card over and placed it in front of the child. A new card, with one cat, was then presented to the child and the child was asked to count the number of cats. This card was also turned over and placed between the child and the first card. The child was then asked to recall the number of cats from the first card followed by the number of cats on the second card. Prompts were given if necessary and the child did not move on to the test trials until it was clear that they understood the procedure.

Test trials were administered using the same method; however no feedback was given. Children's counting totals and recall totals were recorded for each trial. The recall was considered correct if it matched the original counting total and no penalty was given for miscounting. For the two-card trials, one point was awarded for two correct recall totals and a further point for the correct order. For the three-card trials, one point was given for two correct recall totals, two points for three correct recall totals and an additional point for the correct order. Therefore the maximum score for each condition was 15, with a total of 30 points overall. Within each condition, children only moved on to the three-card trials if they had correctly recalled totals for two of the two-card trials, otherwise the trials for that condition were discontinued. See Appendix 4 for the administration scripts for both conditions of the task.

2.5.2.6.3 Cognitive inhibition

The day-night inhibition task (Carlson & Moses, 2001) was used to assess cognitive inhibition. In this task, children were shown two 5cm x 5cm cards; one displayed a picture of the sun and the other a picture of the moon. They were told

the pictures represent day and night, respectively. To provoke an inhibitory response, the child was then required to respond “night” when shown the picture of the sun, and to respond “day” when shown the picture of the moon. The test items consist of 16 further cards (8 x sun, 8 x moon) presented individually and in a randomized order. One point was scored for providing the inhibitory response for each item (maximum 16).

2.5.2.6.4 Cognitive flexibility

The Card Sorting Inhibition task was used to assess children’s cognitive flexibility. This task was adapted from the Dimensional Card Sorting task (Frye, Zelazo, & Palfai, 1995; Kloo & Perner, 2003; Perner & Lang, 2002). Following Kloo and Perner (2003), a third dimension was included to increase the complexity of the task. The task consisted of two sets of nine 6cm x 6cm test cards, three demonstration cards and three target cards. The target cards were affixed to three 14cm × 12cm × 12cm boxes. The test cards could be placed into one of these boxes through a slit on the front side. The task involved three phases: a demonstration trial, a pre-switch, and a post-switch phase. Each test set consisted of nine cards: three of the cards showed a yellow horse, three cards showed a red fish and three cards showed a blue bird. The demonstration set consisted of one of each animal. The target set also consisted of one of each animal; however, the colours were different: red horse, blue fish and yellow bird.

In the task, children were initially shown the demonstration cards and the researcher introduced the animals and colours on the cards. The boxes were placed in front of the child and the animals and colours on the target cards were

explained. Children were then told that they would play the '*colour game*'. The researcher used the demonstration cards, with a verbal commentary, to show that the red card went in the red box, the yellow card went in the yellow box and the blue card went in the blue box. In this pre-switch condition, children were then given the first set of test cards, and asked to play the colour game. Feedback was given and the rules were repeated if they made a mistake. The pre-switch condition was continued until children were performing correctly. In the post-switch condition, children were then given the second set of test cards and told that the nature of the game had changed to the '*animal game*', where they were to put the horse cards in the horse box, the bird in the bird box and the fish in the fish box. As before, if children made a mistake, they were reminded of the rules of the game. Children were required to shift from their previous colour-based response to sorting cards according to the animal shown on the card. One point was scored for each of the cards correctly sorted in the post-switch (animal game) condition (maximum score was 9).

2.5.2.7 Theory of mind (false belief)

Two false belief tasks were used to assess children's theory of mind: an unexpected location task and an unexpected contents task. Both tasks were administered in the same assessment session; however, the order of presentation was counterbalanced.

2.5.2.7.1 Unexpected location false belief task

Based on Wimmer and Perner (1983) and Baron-Cohen, Leslie and Frith (1985), a standard unexpected location task was administered. This task required children

to predict and explain another individual's false belief using an object transfer design. Two small boxes, one blue and one red, were placed equidistance in front of the child. The child was asked to check that the boxes were empty and then requested to put the lids on the boxes. A 'Playmobil®' figure was then introduced to the child as Sally (*"This is Sally. Sally is playing with her ball"*) and a small ball was placed on the table. The researcher used the figure to briefly play with the ball and then place the ball in the blue box and replace the lid (*"She is tired now, so she puts the ball in the BLUE box and goes away."*). Sally was placed in a bag and the child was told that Sally would be unaware of subsequent events (*"She can't hear us and she can't see us."*). A different "Playmobil®" figure was then introduced to the child as Anthony (*"This is Anthony. He wants something to play with. He looks in the BLUE box and finds the ball and plays with it"*). Anthony briefly played with the ball and then placed it in the red box (*"He has finished playing with it now and puts the ball in the RED box and goes away"*). Finally, Sally was reintroduced and she wanted to play with her ball again (*"Sally has woken up now and wants her ball"*). At this point the child was asked the false belief question (*"Where will Sally look first?"*). This was followed by a justification question, (*"Why will she look there first?"*) and two control questions (*"Where did Sally put the ball in the beginning?"* and *"Where is the ball now?"*).

Children were credited with one point for a correct response to the 'false belief' question if they had correctly answered both 'control' questions (e.g., Astington & Jenkins, 1999; Slade & Ruffman, 2005). If the 'belief' question was correct, they were credited with a further point for a relevant response to the justification question (e.g., reference to the original location of the ball or to Sally thinking the

ball had not moved or had not seen it moved). Scores on this task, therefore, ranged from zero to two.

2.5.2.7.2 Unexpected contents false belief task

The unexpected contents task (e.g., Hogrefe, Wimmer, & Perner, 1986) used a misleading contents design, (i.e., a familiar container containing unexpected items) to ask children to recall their own false belief and attribute, and explain, the false belief of another character. A 'Playmobil®' figure was introduced to the child as Jenny and then placed inside a bag. It was explained to the child that Jenny would be unaware of what was happening (*"This is Jenny. I'm going to put her in my bag where she can't see or hear us."*). The child was then shown a closed 'Smarties®' box and asked what was inside (*"What's in here?"*). Following their correct reply (Smarties®, sweets, etc.), the child was shown that the box contained coloured pencils. (*"Let's have a look. Look there are pencils inside. There aren't any Smarties®. Let's put the pencils back inside"*). The child was then asked the reality control question about the contents of the box (*"So do you remember, what's in here?"*). If children did not respond or responded incorrectly they were reminded of the actual contents. Following the control question, the child was asked about his/her own false belief (*"When I first showed you this box, all closed up like this, what did you first think was in there?"*). At this point Jenny was reintroduced (*"Now let's get Jenny"*) and the child was reminded that Jenny didn't see or hear what was in the box. The child was then asked what Jenny ('other' false belief) would initially think is inside the box (*"Remember she didn't see or hear what was inside. When we first show Jenny this box, before she looks inside,*

what will she say is in there?"), followed by a justification question (*"Why will Jenny say there are Smarties®/pencils in there?"*).

Children had to correctly answer the control question to be awarded a score. If correct, they were credited with one point for a correct response to the 'self' false belief question and a further point for a correct response to the 'other' false belief question. Additionally, if they correctly responded to the 'other' false belief question, they were awarded an extra point for a correct justification referring to the box's misleading appearance (Wimmer & Mayringer, 1998). Scores for this task, therefore, ranged from zero to three.

2.5.2.8 Environmental factors

2.5.2.8.1 Print knowledge

The Print Knowledge subtest of the Test of Preschool Early Literacy (TOPEL) (Lonigan, Wagner, Torgeson, & Rashotte, 2007) was used to measure children's print knowledge. The TOPEL measures skills relating to early literacy and is standardized for three to five year olds. The Print Knowledge subtest (12 items) measured early knowledge about written language conventions and form.

Children were asked to point to a picture from four options in response to the researcher's question. For example, the child was presented with a page showing four examples of written text each varying in font size, but filling the same amount of space. The researcher explained that these were stories written by children and asked the child to point to the longest story. The authors report excellent internal consistency ($\alpha = .95$). One point was awarded for each correct response yielding a maximum score of 12.

2.5.2.8.2 Storybook knowledge

Storybook knowledge is considered a proxy measure of the home literacy environment (Sénéchal, LeFevre, Hudson, & Lawson, 1996). To gain a direct measure of storybook knowledge a UK child-administered version of the Title Recognition Task (TRT) was developed (based on Cunningham & Stanovich, 1990; Stanovich & Cunningham, 1993). The task consisted of 15 titles of popular children's storybooks (selected from UK 2010 online retailer's best-seller lists at time of testing) and 15 foils (generated from invented, but plausible, storybook titles, and subsequently investigated to confirm they had not been published; see Appendix 5 for titles and foils). The researcher explained to the child that they would hear the names of storybooks; some of the books they would know and some they would not know because they were for "grown-ups". The researcher then orally presented each title and the child responded "yes" or "no". During the task the child was reassured that they were not expected to know all the titles. As in previous studies, the procedure for scoring the TRT was to subtract the number of selected foils from the number of correctly selected genuine titles (Hood et al., 2008; Farver, Xu, Eppe, & Lonigan, 2006; Sénéchal et al., 1996). Negative scores were considered to be zero and the maximum score was 15.

2.5.2.8.3 Home Environment

2.5.2.8.3.1 *Parental questionnaire*

Parents/ caregivers were asked to complete a family questionnaire to obtain baseline measure of social economic status, home literacy environment and the child's temperament. The questionnaire contained four sections:

- Section 1 was the Child Behaviour Questionnaire (very short form; Putman & Rothbart, 2006), which is a 36-item parent-report temperament questionnaire. (This was not used for this thesis)
- Section 2 requested information about the home literacy environment (child and parent reading habits, number of books in the home, library visits, etc.). These questions were based on HLE questionnaires used in previous studies (Hood et al., 2008; Sénéchal et al., 1996, Sénéchal, LeFevre, Thomas, & Daley, 1998). Details of the HLE section of the questionnaire are discussed fully in Chapter 3.
- Section 3 was concerned with other activities the child liked to engage in outside school (television viewing, library trips etc.).
- Section 4 asked about family structure, e.g., number of siblings, and Social Economic Status (SES; maternal education and occupation, paternal education and occupation). Following Ruffman, Slade, & Crowe (2002), education and occupation were coded on a six-point scale.

2.5.3 Time point 2 (T2): Reception (spring term)

Children (mean age = 4:10 years, SD = 3.8 months) completed a battery of tasks one year after the initial baseline assessments. Several earlier tasks were re-administered to assess development of early literacy and reading readiness. In addition, new expressive language tasks were introduced and two new measures of cognitive inhibition were included. Two further advanced tests of theory of mind were also administered. Children completed two assessment sessions over a period of four weeks. Mean number of days between sessions = 5.91 (SD = 4.26). Children were assigned to one of four groups (two orders of sessions x two order

of tasks within sessions) to counterbalance task administration. A multivariate analysis of variance (MANOVA) on key variables was conducted to explore any group effects on counterbalancing. No significant group differences were found for the MANOVA, Wilk's $\lambda = .73$, $F(24, 207) = 1.00$, $p > .05$, or for the univariate one-way analysis of variance (ANOVA) for each of the key variables (all $p > .05$).

2.5.3.1 Early reading measures

2.5.3.1.1 Single word reading

Children were retested with the single word-reading subtest of the British Ability Scales (Elliott et al., 1983) (see 2.5.2.2.1 for details).

2.5.3.1.2 Letter knowledge

Children's letter knowledge was retested using the Alphabet Knowledge subtest of the PAT (Muter et al., 1997) (see 2.5.2.2.2 for details).

2.5.3.2 Language skills

2.5.3.2.1 Expressive vocabulary

The Definitional Vocabulary Subtest of the TOPEL (Lonigan et al., 2007) was used to gain a measure of the breadth and depth of the children's vocabulary knowledge. This test consisted of 35 items. Each item was represented by a single coloured illustration or collection of illustrations. Children were asked the name of the single item or the collective name of the items. Children were then asked a further question to describe one of its important features, e.g., following the identification of "*money*" as the collective name for pictures of coins and notes,

the child was asked "*What is it used for?*". One point was awarded for the correct answer for each part of the question resulting in a maximum score of 70. Each part of the question was scored independently. The test was discontinued if children scored zero for both parts of three consecutive questions. Lonigan et al. (2007) report excellent internal reliability for the test ($\alpha = .94$).

2.5.3.2.2 Narrative retell

The Renfrew Language Scales: Bus Story Test (Renfrew & Hancox, 1997) is a test of narrative speech, using a story-retell narrative, for three to eight year olds. The assessment involved telling children a story and then asking them to retell the story using pictures in a wordless storybook as prompts. Using the standard script, the researcher initially told the child the story whilst looking at each picture together. The child was then asked to retell the story, using the pictures. The child's narrative was recorded and transcribed onto a scoring form.

The transcription was used to calculate the amount of relevant story information, the mean sentence length (using the five longest sentences) and the number of subordinate clauses. The information measure assessed how much of the key information (32 key pieces of information are specified on the scoring form) from the original story the child used in the retell. For some of the key information, children received credit for responses that matched in meaning, even if identical words were not used. However, others were required to match exactly.

Additionally, points were only awarded for retelling key events in the correct sequence; therefore a measure of understanding of story structure was incorporated in the task. As some items were awarded two points, the maximum

raw score for the information measure was 52. For an example of a coded retell script see Appendix 6.

2.5.3.3 Phonological awareness

The Syllable and Phoneme Completion subtests of the Phonological Abilities Test (PAT; Muter et al., 1997) were re-administered to reassess the children's phonological awareness (see 2.5.2.5 for details).

2.5.3.4 Executive function

2.5.3.4.1 Working memory

The Reverse Word Span task (Slade & Ruffman, 2005) was re-administered to assess working memory (see 2.5.2.6.1 for details).

2.5.3.4.2 Cognitive inhibition (Luria Hand Game)

The first of two tasks used to assess cognitive inhibition was an adaptation of Luria's Hand Game (Hughes, 1998; Luria, Pribam, & Homshaya, 1964).

The child and researcher were positioned to face each other with hands behind their backs. The child was then instructed to copy the hand gesture of the researcher, who brought one hand to the front either showing a fist or a pointed finger. After 15 practice trials, the child was told that the rules had changed and they were now required to make the opposite hand gesture to the researcher (e.g., if the researcher pointed a finger, the child should make a fist). After a brief practice, to ensure the child understood the new rules, there were 15 test trials. The child was awarded one point for each correct trial (maximum 15 points).

2.5.3.4.3 Cognitive inhibition (Wack-A-Mole)

The second task involved a 'Go/No Go' paradigm. 'Go/No Go' inhibitory control tasks measure the ability to withhold a pre-potent response (Durstun et al., 2002). Wack-A-Mole (Stimuli courtesy of Sarah Getz and the Sackler Institute for Developmental Psychobiology) is a computer presented task, programmed using EPrime software (Schneider, Eschman, & Zuccolotto, 2002). The game required children to press the spacebar as fast as possible when a mole appeared out of its hole, but to refrain from pressing the spacebar if a vegetable (an aubergine was used as it was a similar shape to the mole) appeared from the hole. See Appendix 7 for administration script and examples of the stimuli. To ensure children built up a tendency to respond, approximately 75% of the trials were 'Go' trials, although the mole appeared in a variety of 'disguises' (e.g., different hats, wigs), to maintain interest and attention. There were four runs of trials and within each there were 55 images, with each image appearing for approximately two seconds. Overall, the task lasted approximately 8 minutes. The score for the task was the accuracy of the 'No Go' trials.

2.5.3.5 *Theory of mind*

Two advanced tests of theory of mind were used to assess children's social cognition. One task investigated children's belief-desire reasoning and the other involved second-order reasoning to investigate children's ability to understand the belief of one person about the belief of another person. These tasks were administered in the same assessment session and were presented in order of difficulty, with the easiest first (c.f. Wellman & Liu, 2004).

2.5.3.5.1 False belief desire reasoning task

This task assesses children's "belief-desire reasoning" (Harris, Johnson, Hutton, Andrews, & Cooke, 1989) through a story involving a 'nasty' surprise. At the beginning of the task, children were introduced to two soft toy characters: Chris the crocodile and Danny the dog. Children were told that Chris was naughty and liked to play tricks on his friend Danny. The child was then told that Danny really liked cola and that he did not like any other drinks especially milk. Two emotion contingency questions were asked to check whether the child understood the likes and dislikes of the key protagonist (*"How does Danny feel when he gets a can of cola/gets some milk?"*). Children were then told a story using props, which involved Chris substituting the contents of Danny's cola can with milk, while Danny was out for a walk. The story continued with Danny returning thirsty from his walk and able to see the cola can, but not able to see what was inside. At this point, children were asked the test question to predict the false belief based emotion (*"When Danny first comes back from his walk, how does he feel – happy or not happy?"*) followed by a justification question (*"Why does he feel happy/not happy?"*). Next, children were asked a first-order 'other' false belief test question (*"What does Danny think is in the can?"*) and the control reality question (*"What is in the can really?"*). Two final emotion contingency questions were asked (*"How does Danny feel after he's had a drink – happy or not happy?"* and *"Why is he not happy?"*). One point was awarded for the belief based emotion test question if all four emotion contingency questions and the control reality question had been answered correctly. A further point was awarded for justification if the belief based emotion question was correct. Finally, an additional point was credited for the 'other' false belief test question if the reality control question was correct. The maximum score was 3.

2.5.3.5.2 Unexpected location second-order false belief task

A second-order false belief story (Perner & Wimmer, 1985) was told to the children using a series of four picture cards (see Appendix 8). With the first picture, children are told that Granddad has given Mary and Simon some chocolate to share and they need to put it away until Mum tells them they can eat it. The second picture showed Mary and Simon in the kitchen putting the chocolate in the fridge. Children are then told that the two siblings go out to play. With the third picture, children are told that Simon wanted to keep the chocolate for himself, so he took it out of the fridge and put it in his bag. At this point the child is asked two control questions (*"Where does Mary think the chocolate is?"* and *"Where has Simon put the chocolate really?"*). If the child failed either of the control questions the story was repeated.

The fourth picture showed Mary looking through the kitchen window and children were told that she was watching everything Simon was doing and she saw him put the chocolate in his bag. Simon was so busy hiding the chocolate that he did not see that Mary was watching him. Later, Mary and Simon went to the kitchen, as Mum said they could have some chocolate. Children were then asked the test question (*"Where does Simon think Mary will look for the chocolate?"*) followed by the justification question (*"Why does Simon think that?"*). Finally, children were asked a reality control question (*"Where is the chocolate really?"*) and a memory control question (*"Where was the chocolate first of all?"*). One point was awarded for the second-order false belief test question, if both the reality and memory control questions were correct. A further point was given for the justification, if the test question was correct to give a maximum score of two.

2.5.3.6 Environmental factors

2.5.3.6.1 Print knowledge

The Print Knowledge subtest of the Test of Preschool Early Literacy (TOPEL) (Lonigan et al., 2007) was used to retest children's print knowledge (see 2.5.2.8.1 for details).

2.5.4 Time point 3 (T3): Reception (end summer term)

Children (mean age = 5:02 years, $SD = 3.8$ months) completed a further assessment at the end of the academic year. In line with the dimensions of the SVR, children's word reading ability and listening comprehension were assessed. Children completed two assessment sessions over a period of two weeks. Mean number of days between sessions = 4.46 ($SD = 2.34$). Children were assigned to one of four groups (two orders of sessions x two order of tasks within sessions). A multivariate analysis of variance (MANOVA) on single word reading and listening comprehension was conducted to explore any group effects on counterbalancing. No significant group differences were found for the MANOVA, Wilk's $\lambda = .95$, $F(6, 156) = 0.61$, $p > .05$, or for the univariate one-way analysis of variance (ANOVA) for each of the variables (both $p > .05$).

2.5.4.1 Early reading measures

2.5.4.1.1 Letter knowledge

The Letter Sound Knowledge subtest of the York Assessment of Reading for Comprehension Early Reading (YARC Early Reading; Snowling et al., 2011) was used to assess the children's letter sound knowledge. Each letter of the alphabet

and six digraphs were presented individually to the child. One point was awarded for each correct sound, giving a maximum score of 32.

2.5.4.1.2 Single word reading

The Early Word Recognition subtest of the YARC (Snowling et al., 2011) was used to assess emergent word reading skills. The test consisted of 30 words; all familiar to young children, but found in varying frequency in children's literature. The test consisted of 15 regular words (e.g., frog), which can be phonologically decoded according to Grapheme Phoneme Correspondence rules to produce the correct pronunciation, and 15 irregular words (e.g., bird), which cannot be read correctly using phonological decoding. One point was awarded for each correct word, giving a maximum score of 30. Snowling et al. (2011) report a mean raw score of 8.5 words ($SD = 8$; range 0 – 30) for children in their reception year and 20.6 words ($SD = 9$; range 5 – 30) for children in Year 1. Children in the current study showed a mean score of 13.6 words ($SD = 8$), which appeared to be consistent with the reported results, as children were at the *end* of their reception year at time of assessment.

2.5.4.2 *Listening comprehension*

The first three stories taken from the Neale Analysis of Reading Ability (NARA; Neale, 1997) were administered orally (read aloud by the researcher) and used to assess children's listening comprehension. The NARA is a standardized assessment of passage text reading and comprehension for six to nine year olds. Standardized reading comprehension tests have been used to measure listening comprehension in previous research (Nation, Cocksey, Taylor, & Bishop, 2010).

For each story, the accompanying black and white illustration was placed in front of the child and the researcher read the story. Children did not see the text. Following each story, the researcher asked the comprehension questions, which consisted of literal, e.g., “Where was Kim going?” (Answer: To school) and inferential questions, e.g., “How do you think Kim felt?” (Answer: Frightened/ worried or similar). The stories were presented in sequence, as they increase in length and difficulty. The test was discontinued when children did not correctly answer any of the comprehension questions for the previous story. Children’s answers were transcribed verbatim and scored according to test procedure. One point was awarded for each correct answer. The maximum raw score was 24.

2.5.5 Time point 4 (T4): Year 1 (end summer term)

Children (mean age = 6:03 years, SD = 3.9 months) completed an extensive battery of tasks one year later at the end of Year 1. At this time, children completed their first reading comprehension test. In addition, children were reassessed in language skills (receptive vocabulary and narrative comprehension), word reading ability, PA, executive function and theory of mind. As previously noted, it was necessary to use alternative tests to measure the same constructs between time points to avoid potential ceiling effects. To address this issue, new executive function tasks were included to assess cognitive inhibition and working memory. Happé’s Strange Stories (Happé, 1994; O’Hare, Bremner, Nash, Happé, & Pettigrew, 2009) were administered to assess children’s theory of mind. Additionally, to assess children’s fluency and accuracy in word reading, timed tests of both word and non-word reading were administered.

Children completed three assessment sessions over a period of four weeks (mean number of days between first and last session = 15.91 ($SD = 6.27$). Children were assigned to one of six groups (three orders of sessions x two order of tasks within sessions). The effects of counterbalancing between the six order conditions were explored using a multivariate analysis of variance (MANOVA) on key variables. No significant group differences were found for the omnibus MANOVA, Wilk's $\lambda = .63$, $F(40, 277) = 0.78$, $p > .05$, or for the univariate one-way analysis of variance (ANOVA) of any of the key variables (all $p > .05$).

2.5.5.1 Reading comprehension

The York Assessment of Reading for Comprehension: Passage Reading (YARC; Snowling et al., 2011) was used to assess children's comprehension skills. The standardized test comprises of graded passages, alternating between fiction and non-fiction, for reading aloud by children aged five to 11 years. Children were required to read two passages. Following each passage, children were asked a set of eight comprehension questions tapping literal and inferential comprehension skills.

In preparation for the YARC, children completed the Single Word Reading Test (SWRT; Foster, 2007). This test consists of six graded sets of ten words of increased difficulty. The raw score from the SWRT determined the starting passage level for the YARC. Children then completed two consecutive passages from the YARC. Children were timed as they read the passages aloud, with the exception of the beginner's passage. The accuracy of their reading was recorded for all passages. Answers to comprehension questions were transcribed and scored according to test instructions.

Standard scores were calculated for comprehension skills, accuracy of reading and, when possible, reading rate; however only the comprehension score is used in the analysis in the current study. In light of the SVR, reading efficiency was measured as word, rather than passage reading, so therefore an alternative test was used (see 2.5.5.2).

2.5.5.2 Reading efficiency

The Test of Word Reading Efficiency (TOWRE; Torgesen, Wagner, & Rashotte, 1999) was used to measure children's word reading accuracy and fluency. The TOWRE is standardized from six years old and consists of two subtests to provide measures of sight word reading efficiency and decoding efficiency. The Sight Word Efficiency (SWE) subtest assesses the number of real printed words that can be accurately identified within 45 seconds. The Phonetic Decoding Efficiency (PDE) subtest measures the number of viable printed non-words that can be accurately decoded within 45 seconds. Data from the subtests are combined to provide an overall reading efficiency score.

As mentioned above, the TOWRE is standardized from six years, but there was some concern about the reliability of the test for a young population. However, analysis revealed that standard scores from the TOWRE compared favourably with other concurrent indicators of reading ability. Strong correlations were found between the TOWRE and measures from the SWRT, YARC passage reading accuracy and YARC passage reading rate ($r = .86, .83, .89$ respectively).

2.5.5.3 *Language skills*

2.5.5.3.1 Receptive vocabulary

The British Picture Vocabulary Scale: 2nd Edition (Dunn et al., 1997) was re-administered to assess the children's receptive vocabulary (see 2.5.2.3). However, at this time, children completed up to ten sets of 12 words giving a potential maximum score of 120.

2.5.5.3.2 Narrative comprehension

Children's narrative recall and comprehension ability was assessed using a task based on the work of Paris and Paris (2003). A shorter form of a wordless picture book ("Robot-Bot-Bot" by Fernando Krahn) was given to the child to 'read'.

Children were asked to use the book to tell the story to the researcher. Children were encouraged to use the book and turn the pages, but they were not given any prompts in relation to the storyline. After children had finished telling the story, the book was removed from the child's vicinity. Children were then asked to retell the story. After the retelling, children were asked if they could remember anything else about the story, but no further prompts were given. Children's recall was recorded and later transcribed in full.

Following the recall, the book was replaced in front of the child and the researcher told the child that they would go through the book together a second time while the researcher asked some questions about the pictures. The researcher guided the page turning and asked the child a series of ten comprehension questions, turning to the corresponding page of the book before asking each question. Five of the comprehension questions were about explicit

information in the story, requiring identification of characters, setting, initiating event, the problem and outcome resolution. Paris and Paris (2003, p.44) define narrative comprehension as “the construction of meaning from pictures by integrating information across pages to create coherent and connected understandings”. To encourage children to demonstrate narrative comprehension, each of the three latter explicit questions were followed by “*why do you think so?*”

The other five comprehension questions asked about implicit information from the story and required children to make inferences from the pictures. These questions asked about character’s feelings, dialogues, causal relations, predictions and the overall theme. Each of the inferential questions was followed with a “why” prompt, to give children the opportunity to connect their inferences to other story events. Children’s responses were transcribed in full.

Scoring for the retell categorized children’s transcribed responses into six elements of the narrative (characters, setting, goal, problem, solution, ending) and one point was awarded for the presence of each element. Additionally, up to three further points were awarded for awareness of story structure. Children who had not included any narrative elements received a zero score and those who included beginning information only or recounted the story as an incorrect sequence of events received one point. Two points were awarded for the appropriate sequencing of two parts of the story (i.e., beginning/middle or middle/end) and three points for the appropriate ordering of all parts of the story (beginning, middle and end). Character and setting information was considered to be the beginning of the story, goal and problem were the middle and solution and

ending were considered to be the end. Consequently, the retell element of the task yielded a potential maximum raw score of 9 points.

The comprehension questions were scored using a scoring rubric from Paris & Paris (2003). The 0-1-2 point rubric was designed to reflect story coherence; therefore more points were awarded for integration of information across the pictures and story rather than the description of a single picture. Zero points indicated no response or irrelevant and inappropriate answers. One point was awarded when the response had been derived from a single picture. Two points were awarded when information from multiple pictures had been integrated to create a coherent explanation. Two totals were calculated for the explicit and implicit comprehension questions and they were summed for an overall comprehension total (maximum score = 20). An overall narrative comprehension score was calculated by summing the recall and comprehension scores to give a maximum total of 29.

Inter-rater reliability was checked across the sample. Retell and comprehension transcripts for both cohorts were scored simultaneously. Two researchers assessed a random selection of retell transcripts, using the procedure described by Paris & Paris (2003), to develop scoring instructions. One of the researchers then scored all transcripts and another third researcher independently scored 64 (80%) of the scripts. Similarly to Paris and Paris (2003), inter-rater reliability was excellent, with above 90% agreement for every item and an average of 93% agreement across all items.

A similar procedure was used for the comprehension questions. Using the 0-1-2 scoring rubric (Paris & Paris, 2003), two researchers scored responses from a

random selection of scripts. As before, one researcher then scored all scripts and a third, independent researcher scored 41 (51%) of the scripts. Once again, inter-rater reliability was excellent at 90% or above across all the questions, with an average of 94%.

2.5.5.4 Phonological awareness

Two subtests (Elision and Blending words) of the Comprehensive Test of Phonological Processing (CTOPP; Wagner, Torgesen, & Rashotte, 1999) were used to assess children's phonological processing. The CTOPP is standardized for children from the age of five and upward.

2.5.5.4.1 Elision

The Elision subtest measured the ability to say a word, and then say what is left after omitting a designated sound. The test consisted of 20 items. For the first two test items, children were required to repeat a compound word spoken by the researcher and then they were requested to say the remaining word after dropping one of the compound words. For example "*Say popcorn. Now say popcorn without saying corn*" The correct answer is "pop." The third item required children to omit a syllable that is part of the word (e.g., "spider" – omit "der" – leaves "spy"). For the remaining 17 test items, the children were asked to say the word without a specified phoneme. For example "*Say bold. Now say bold without saying /b/.*" The correct answer is "old." The test items increased in levels of difficulty, requiring a greater degree of phonological manipulation. One point was awarded for each correct answer, giving a maximum score of 20. The test was discontinued after three consecutive zero scores.

2.5.5.4.2 Blending words

The Blending Words subtest measured children's ability to combine sounds to form words. Children listened to a series of recorded separate sounds and were asked to put the separate sounds together to make a whole word. For example, children were asked, "*What word do these sounds make: t-oi?*" The correct answer is "toy". The test items increased in difficulty, with a greater number of sounds making more complex words. In total, there were 20 test items and one point is awarded for each correct word, giving a maximum score of 20. As before, the test was discontinued after three consecutive zero scores.

2.5.5.5 *Executive function*

2.5.5.5.1 Working memory

Children completed two working memory tasks to assess the processing and storage of digits and words (Cain, Oakhill, & Bryant, 2004a). The digit working memory task required children to read aloud groups of three digits and remember the last digit from each group in the same order as presentation for later recall. As children had to read out each group aloud, they could not succeed at the task by simply remembering the last digit of each group. The researcher explained to the child that they were going to play a remembering game and that they would see two groups of numbers that they should read aloud. Children were told to try to remember the last number from each group, they would be asked to repeat those numbers. Using a booklet of 12cm x 6 cm cards, children were shown the first card showing three digits. After they had spoken the numbers aloud, the card was flipped over and the next set of digits was shown to the child. As before, the card was flipped over and then the child was asked to

recall the last digit from each group of numbers. The practice session continued until the child clearly understood the procedure.

The first test trials consisted of two groups of digits; therefore requiring two final digits to be recalled. Following three trials of two-group items, the demands of the task were increased and children were asked to recall from three trials of three-group items and three trials of four-group items. Children were encouraged to recall the numbers in the correct order, although children responding in a different order but specifying the position of the number e.g., “the last number was 2 and the first one was 5” were credited with points. One point was awarded for every correct digit that was recalled in its correct location. The exception was when the last digit from the final group of numbers was the only recalled item, which received a zero score. The potential maximum raw score was 27.

The sentence-span task involved a similar procedure. Children listened to groups of short sentences with the final word missing, e.g., 1. *The spider caught a fly in her _____(web)/* 2. *He went to the library to look at a _____(book).* Children were required to finish the sentences and remember their words for later recall, once again in the same order as presentation. Similarly to the digit task, the initial trials consisted of two groups of sentences; therefore requiring two final words to be recalled. Following three trials of two-group items, children were asked to recall from three trials of three-group items and three trials of four-group items. Correct recall was the repetition of the words that children had supplied, no penalty was incurred for initially using a different choice of word than was expected.

As before, children were encouraged to recall the words in the correct order, but still received points if the order was specified. One point was awarded for every correct word that was recalled in its correct location, with the exception of single recall of the last word from the last sentence in a group. The maximum raw score was 27.

2.5.5.5.2 Cognitive inhibition

A new task was developed using the Stroop paradigm, based on Prevor and Diamond (2005), to assess cognitive inhibition: the Colour/Object Switch Task. The task consisted of three timed tests. The first required children to name the colour of 20 coloured line drawings of squares (4 x 5 colours: pink, blue, yellow, orange, green). The second required them to name 20 line drawings of objects (4 x 5 object types: pig, whale, sun, carrot, frog) shown in their congruent colours, e.g., pink pig, blue whale. In the third test, children were shown another 20 line drawings of the same objects, but this time the drawings used incongruent colours, and children were asked to name the colours. Test stimuli can be found in Appendix 9. The aim of the test was to measure cognitive interference resulting from the effects of the incongruent use of the colours and objects.

Initially, children were shown a practice page, showing one of each coloured squares and one of each object, and asked to name each of the colours and objects. Feedback was given until children could name all items. Before the timed tests, children were told that the aim of the game was to name the items as fast as possible. The first test page was placed in front of the child, but remained covered until the researcher started timing. The same procedure was used for the second

and third timed tests. The interference score (measured in seconds) was calculated by subtracting the predicted score (mean time of test 1 and test 2) from the time of test three.

2.5.5.6 Theory of mind

To provide a further advanced measure of theory of mind, children were assessed using an adapted selection of Happé's Strange Stories (Happé, 1994; O'Hare et al., 2009). The aim of the task was to tap into mentalizing concepts through a selection of simple stories where, in each, the protagonist has motivation to tell an untruth, creating a range of statements that were not literally true. Six stories were used. Each story included one of six mentalizing concepts: sarcasm, belief-based misunderstanding, contrary emotions, display, faux pas or double bluff. For example, belief-based understanding was represented in a story about a policeman and a burglar. The burglar was running away after having stolen some goods from a shop and, as he ran past a policeman, he dropped his glove. The policeman retrieved the glove and called for the burglar to stop, so that he could return the glove. The burglar misunderstood the policeman's intension and put his hands up to give himself up. Faux pas was demonstrated with a story about a boy who visited his neighbour's house and mistook her young niece to be a little boy. See Appendix 10 for full scripts and illustrations for these stories.

In contrast to O'Hare et al. (2009), where the stories were read in a set order by the researcher, the stories in this study were presented to children on a computer using a recorded PowerPoint presentation in one of four orders. The researcher introduced the task by explaining to the child "*We are going to watch and listen to*

some stories on the computer. I want you to listen carefully, because at the end of each story I am going to ask you some questions to see what you thought of the story." The presentation of each story involved a sequence of two to four coloured cartoon drawings that appeared on the screen as each story was recounted.

After each story, the researcher asked the corresponding questions, the first of which was the comprehension control question "*Was it true what X said?*" The following question related to the mentalizing aspect of the story and, for some stories, there were additional reality control questions. In line with O'Hare et al. (2009), children were allowed to listen to each story twice, either because they asked for it to be repeated or because they answered "I don't know" to the first comprehension control question. During administration of the questions, the researcher provided positive encouragement, but no direct feedback on the accuracy of children's responses or further prompts were given. The researcher transcribed children's answers in full.

The 0-1-2 scoring rubric for the mentalizing test questions was taken from O'Hare et al. (2009). The response for each question was allocated to one of four categories: incorrect, physical state, partial psychological state or psychological state full and accurate answer. The first two categories were both considered incorrect, as the question did not ask about physical events or outcomes, and both received no points. The psychological categories received one point for a partial answer and two points for a full and accurate answer. For the full two points, an answer had to include "thoughts, feelings, desires, traits and dispositions (e.g., like, want, happy, cross, afraid, know, think, joke, pretend, lie, fool someone,

expecting)” (O’Hare et al., 2009; p. 918). The potential maximum raw score was 12.

Responses from the two cohorts were marked simultaneously. Two researchers discussed a range of responses from a random selection and reached a consensus in the allocation of the answers to the four categories. Subsequently, the author independently marked all scripts and a second researcher marked blind 27% of the children’s responses. Inter-rater reliability was excellent with 98% for faux pas, sarcasm, double bluff and misunderstanding, 96% for contrary emotion and 89% for display. Overall inter-rater reliability was found to be 95% (Kappa = .91, $p < .001$).

In contrast, to O’Hare et al. (2009) the scores were adjusted in consideration of the comprehension control question; points for the mentalizing question were awarded only if the comprehension control question(s) were correct. The unadjusted and adjusted scores for the Strange Stories task were highly correlated ($r = .9$, $p < .001$), but it was considered that using the adjusted scores was more consistent with the theory-of-mind measures at earlier time points.

2.6 Analysis

As previously noted, children completed standardized assessments wherever possible; however, it was also necessary to adapt tasks or develop novel tasks to find age appropriate testing materials. As a consequence, raw scores have generally been used for analyses throughout the study. There are three notable exceptions: The Block Design subtest of WPPSI-III (Wechsler, 2002) non-verbal

ability, TOWRE (Torgesen et al., 1999) word reading efficiency and YARC (Snowling et al., 2011) reading comprehension. The TOWRE yields two separate standard scores, one for word reading and the other for non-word reading. The two scores are used to calculate an overall reading efficiency standard score, which more accurately corresponds to the word reading dimension proposed by the SVR (see 1. 2.1) than single word reading alone. The YARC requires children to complete two consecutive passages; however, the level of passages is dependent on children's single word reading ability, therefore children complete a variety of combination of passages. Consequently, raw scores are not comparable between individuals.

In general, correlation and regression analyses have been used to examine these data. Maturational effects are a major consideration in research with young populations. The current study examined the development of cognitive abilities in children between the ages of three to six years; therefore controlling for age in the analyses was crucial. However, using both raw and standard scores together in the regression analyses was a potential problem, because it was essential to control for age when using raw scores, but age had already been accounted for in standard scores. In order to address this issue, all variables measured through raw scores were residualized for age before being entered into regressions, thus becoming age-independent variables (Durand, Hulme, Larkin, & Snowling, 2005). Each variable was regressed on its corresponding age (at the relevant assessment time point). The standardized residual was then used as the age-independent variable. All residuals were examined to confirm that they showed a normal distribution.

Regression analyses were at the core of the experimental chapters reported in this thesis, as the primary aim was to examine the unique contribution of early pre-reading variables to the later acquisition of reading comprehension. A rigorous approach was taken for each series of analyses, following procedures recommended by Field (2009). Initially, variables were selected based on the research question; however, zero order correlations were then used to determine significant relationships between variables and the outcome variable. Variables were excluded from the regression analyses if there was no significant relationship with the outcome variable.

Analysis was performed using SPSS REGRESSION and SPSS EXPLORE for evaluation of assumptions (Tabachnick & Fidell, 2007). After each step of the regression, residual data was examined to check and address violation of assumptions of normality. Where a significant skew was found in the distribution of standardized residuals, further investigation was conducted to identify multivariate outliers. Individual standardized residuals were examined and cases with standardized residual outside the -2.5 to 2.5 range were further explored. Where residual data revealed a normal distribution, individual standardized residuals were still examined to confirm that any cases beyond the -2.5 to 2.5 range accounted for less than 5% of participants (Field, 2009). Influence statistics (Mahalanobis Distance, Cooks Distance and Leverage values) were used to identify multivariate outliers. Where multivariate outliers were identified, their data were excluded and the analysis was rerun with the remaining sample. Evaluation of assumptions was repeated to confirm normal distribution of residuals for each step of the regression and the final regression model.

2.7 Summary

This thesis examines the early pathways from the preschool home literacy environment, through the first years of education, to the acquisition of reading comprehension at the end of Year 1. Children completed extensive batteries of cognitive and socio-cognitive assessment at numerous time points throughout the three-year study. This chapter provided details of the overall design and nuances of the study. Descriptive information regarding participants and their schools was also included. Finally, it provided comprehensive details of the assessment materials and procedures used in the studies reported in this thesis. Table 2.4 provides a summary outlining the study design and tasks administered at each time point. The following chapters in this thesis report the results of experimental studies, each using a combination of the materials reported in this chapter. For brevity, only brief summaries of materials and procedures, supported with references to this chapter, will be reported in the following experimental chapters.

Table 2.4: Summary of assessment tasks administered at each time point

	Time 1 Nursery	Time 2 Reception	Time 3 Reception	Time 4 End Y1
Age				
Years: months (<i>SD</i>)	3:10 (3.7)	4:10 (3.8)	5:02 (3.8)	6:03 (3.8)
Non-verbal ability				
WPPSI-III Block design	X			
Early reading				
BAS Single word reading	X	X		
PAT Alphabet knowledge	X	X		
YARC Letter sound knowledge			X	
YARC early word recognition			X	
TOWRE reading efficiency				X
Vocabulary				
BPVS-II	X			X
TOPEL Definitional vocabulary		X		
Language				
CELF Linguistic concepts	X			
CELF Recalling sentences	X			
Renfrew Language Scales: Bus story test		X		
Listening comprehension using NARA			X	
Narrative recall and comprehension (Robot)				X
Phonological awareness				
PAT Rhyme completion	X	X		
PAT Word completion	X	X		
CTOPP Elision				X
CTOPP Blending words				X
Executive function				
Working memory				
Reverse word span	X	X		
Cat & mouse digit task	X			
Digit WM task				X
Sentence-span task				X
Cognitive inhibition				
Day/night task	X			
Card sorting task	X			
Luria hand game		X		
Wack-a-mole		X		
Colour/object switch task				X
Print knowledge				
TOPEL Print knowledge	X			
Home literacy environment				
Title recognition task	X			
Parental questionnaire	X			
Theory of mind				
Unexpected location FB task (Sally/Anne)	X			
Unexpected contents FB task (Smarties)	X			
FB desire reasoning task (nasty surprise)		X		
2 nd order FB task (chocolate)		X		
Strange stories				X
Reading comprehension				
YARC: Passage reading				X

Notes: WPPSI-III= Wechsler Preschool and Primary Scale of Intelligence – Third Edition (Wechsler, 2002); BAS = British Ability Scales (Elliott, Murray & Pearson, 1983); PAT = Phonological Abilities Test (Muter, Hulme & Snowling, 1997); YARC = York Assessment of Reading Comprehension (Snowling et al., 2011); TOWRE = Test of Word Reading Efficiency (Torgesen, Wagner & Rashotte, 1999); BPVS-II = British Picture Vocabulary Scale: 2nd Edition (Dunn, Dunn, Whetton & Burley (1997); TOPEL = Test of Preschool Early Literacy (Lonigan, Wagner, Torgeson & Rashotte, 2007); CELF = Clinical Evaluation of Language Fundamentals – Preschool Second Edition (Wiig, Secord & Semel, 1992); NARA = Neale Analysis of Reading Ability (Neale, 1997); CTOPP = Comprehensive Test of Phonological Processing (Wagner, Torgesen & Rashotte, 1999); WM = working memory; FB = false belief; Y1 = Year 1

Chapter 3 The Home Literacy Environment

3.1 Introduction

In addition to the social and emotional benefits of shared book reading, recent research has demonstrated that exposure to literacy related practices in the home environment promotes children's later language and reading skills at school (e.g., de Jong & Leseman, 2001; Hood, Conlon, & Andrews, 2008; Sénéchal, LeFevre, Thomas, & Daly, 1998; Sénéchal & Young, 2008). Research of the home literacy environment (HLE) has yielded evidence that there are two distinct types of literacy practices at home; one of which contributes to developing decoding skills and the other to language skills (Sénéchal & LeFevre, 2002). Within the framework of the Simple View of Reading (SVR; Gough & Tunmer, 1986; Hoover & Gough, 1990), where skilled reading comprehension involves two separate dimensions (word recognition and linguistic comprehension), it would seem that the two separate HLE practices independently contribute to one or the other of the SVR dimensions.

Both dimensions of the SVR, independently, contribute directly to reading comprehension; however recent evidence has suggested that language comprehension may also influence developing decoding skills and that, due to developmental constraints, the relationships between the dimension components may change over time (Tunmer & Chapman, 2012a). Further research has demonstrated that, as children progress through formal education, the influence of the HLE also changes over time, (Sénéchal & LeFevre, 2014). However, the very early relationships between home literacy practices and the acquisition of the foundation skills underpinning the constituent components of the SVR are less

well understood. To explore how literacy experiences at home affect children's abilities in the precursory skills underlying reading comprehension, it is crucial to assess children before they begin formal education.

The current longitudinal study aimed to address this issue by examining whether early literacy experiences in the home were directly associated with key cognitive abilities (letter knowledge, print knowledge, phonological awareness and receptive vocabulary) that have been shown to be robustly linked to early literacy in school-aged children (Kendeou, van den Broek, White, & Lynch, 2009b; Storch & Whitehurst, 2002). Importantly, these skills were initially assessed in very young children (aged three to four years) at the beginning of preschool, before the beginning of formal reading instruction. Subsequently, children's progress was tracked through preschool and their first year of formal education (aged 5) to investigate whether the benefits of their early home literacy experiences endured, to predict either or both dimensions of the SVR over and above those key cognitive factors mentioned above. Additionally, by the final time point, children had completed a year of formal literacy instruction; however, they were only five years old, which is a year younger than previous HLE research. Therefore, this study aimed to further extend current knowledge of the HLE to examine whether changes in the influence of home literacy practices, following a year of formal literacy instruction, result from formal teaching of reading skills or as a result of maturation.

3.1.1 The Home Literacy Environment

Within the literature, HLE covers a broad category of factors relating to children's literacy experiences. In general, the measure includes frequency of shared (parent/child) reading, frequency of library visits with the child, number of children's books in the home, age when reading to the child began and frequency of parental teaching of literacy skills. Sénéchal and colleagues (Sénéchal & LeFevre, 2002; Sénéchal et al., 1998) propose that overall there are two distinct forms of parent-child interaction within the HLE. These interactions are categorised as 'informal' and 'formal' activities. Specifically, *informal* literacy experiences expose children to storybooks whilst focusing on the message of the print rather than the print itself, and *formal* literacy experiences involve direct parental teaching of letters and words. In their empirically based Home Literacy Model, Sénéchal and LeFevre (2002) propose that *informal* literacy experiences promote children's receptive language skills. In contrast, *formal* literacy experiences support early decoding skills such as letter knowledge and single word reading.

Research consistently shows that pre-school children's exposure to storybooks accounts for unique variance (5.6% - 13%) in receptive language (Fritjers, Barron, & Bruello, 2000; Hood et al. 2008; Sénéchal, 2006; Sénéchal & LeFevre, 2002,). In contrast, the majority of studies fail to find a direct relationship between shared book reading and letter knowledge (Evans, Shaw, & Bell, 2000; Fritjers et al., 2000; Hood et al., 2008; Sénéchal & LeFevre, 2002;). There is more limited research investigating the relationship between formal parent-child teaching practices and emerging literacy skills; however, studies have shown that the frequency of parent-child teaching practices do account for unique variance

(5% - 10%) in early letter and word identification skills in five to six year olds, after controlling for age, cognitive ability, PA, parental education and storybook exposure (Evans et al., 2000; Hood et al., 2008; Martini & Sénéchal, 2012; Sénéchal, 2006; Sénéchal & LeFevre, 2002).

Research suggests that although the two distinct home literacy practices are significant predictors of early literacy skills at the beginning of formal education, the pathways become indirect after the start of formal education (de Jong & Leeseaman, 2001; Hood et al., 2008; Sénéchal & LeFevre, 2002). Sénéchal and LeFevre (2002) propose that there is a direct pathway from preschool storybook exposure to receptive language skills (a composite measure of receptive vocabulary and listening comprehension) at the beginning of Grade 1 (aged six years), and receptive language ability then predicts word reading and comprehension at the end of Grade 3 (aged eight years). Similarly, there is a direct pathway from preschool parental literacy teaching to emergent literacy skills (letter knowledge and single word reading) in Grade 1 (Evans et al., 2000; Sénéchal, 2006; Sénéchal & LeFevre, 2002). These emergent literacy skills in turn predict more advanced reading skills at the end of Grades 3 and 4 (Sénéchal, 2006; Sénéchal & LeFevre, 2002). However, it is unclear whether the mediating effect of emergent literacy skills is due to the introduction of formal literacy instruction at school or whether it is an age-related maturational pathway. In the UK, children begin formal education at four to five years, one year younger than those typically assessed in the HLE literature. The present research was therefore able to test the Home Literacy Model with five-year-old children, after they had completed a full year of formal literacy instruction, to investigate whether the

effects of the home literacy environment on children's emergent literacy skills would become indirect even at this younger age.

In addition to investigating formal and informal literacy practices, other studies have also included measures of children's interest in home literacy practices. It has been suggested that lack of interest by the child may affect the frequency of home literacy activities (Hood et al, 2008; Martini & Sénéchal, 2012; Sénéchal, LeFevre, Hudson, & Lawson, 1996). Mixed results have been found with respect to the contribution of children's interest in home literacy practices to later reading related skills. Sénéchal et al (1996) found that children's interest in 'being read to' accounted for 5% of variance in vocabulary, but Hood et al. (2008) found no significant relationship. Further studies have found that children's interest in literacy activities is a unique predictor of letter knowledge (Fritjers et al., 2000) and emergent reading (Martini & Sénéchal, 2012). These findings are consistent with the view that an interested child may gain additional benefit from home literacy practices over an uninterested child (Baroody & Diamond, 2012; Martini & Sénéchal, 2012). Researchers in these studies have measured children's interest as the frequency of requesting being read to or as a more general interest in literacy practices, e.g., looking at books.

However, neither type of measure has quantified the quality of the interaction between parent and child during literacy activities at home. Other research has found that children rarely look at print during shared parent/child book reading (Evans & Shaw, 2008), although it has been demonstrated that drawing children's attention to the print is more effective than passive listening alone (Levy, Gong, Hessels, Evans, & Jared, 2006; Piasta, Justice, McGinty, & Kaderavek, 2012).

Additionally, it has been found that extra-textual comments and questions from parents during shared reading also contributed to additional vocabulary growth (Blewitt, Rump, Shealy, & Cook, 2009). Therefore, it is a further aim of the present study to extend these aspects of child interest in literacy activities, which may influence the frequency of home literacy activities, to also examine the quality of the child's engagement *during* these activities and how it may affect the children's emerging literacy skills.

3.1.2 Measuring the Home Literacy Environment

In the majority of studies the HLE is measured through parent report either as a questionnaire or as a semi-structured interview. As with all self-report measures there is a potential social desirability effect when using the parental-completed questionnaire to estimate the literacy environment. To avoid these potential difficulties a further proxy measure has been developed to indirectly measure the child's exposure to books (Sénéchal et al., 1996). This approach uses a parent-completed children's title recognition task (TRT) and children's author recognition task (ART), which is based on the checklist paradigm developed by Stanovich & West (1989). Each test includes a number of authentic titles/authors of children's books along with credible foils; the theory is that the foils account for response bias as the number erroneously selected as authentic are subtracted from the number of real titles/authors selected. Sénéchal et al. (1996) suggest that this is a more objective method of measuring book exposure. However, the TRT, ART and the questionnaire items are significantly correlated suggesting that they are all tapping into the HLE construct (Hood et al., 2008) and several studies use a composite of TRT and questionnaire items. Other studies have used a child-

administered version of the TRT using book-cover recognition (Davidse, de Jong, Bus, Huijbregts, & Swaab, 2011; Sénéchal et al., 1996). In these tasks, children were asked about the title, characters and plot of each book, but the title was considered to be the most reliable measure. However, this task may have limitations due to many characters from popular children's literature being portrayed on television and film (Stainthorp, 1997). To address this issue, a new child-administered, UK version of TRT was developed for the current study.

Items for the novel TRT were selected from UK online retailers' best-seller lists. Books featuring popular characters from television and film were excluded. An equal number of plausible titles were created as foils. The TRT was presented orally to the child and the results were used to form a composite with parent-report items to capture a richer measure of storybook exposure.

3.1.3 The Home Literacy Environment and pre-reading skills

The Home Literacy Model describes distinct pathways from home literacy experiences to receptive language and decoding skills at the beginning of formal education; however a wealth of research has shown that the acquisition and growth of emergent literacy skills is a complex, multifaceted process (e.g., National Institute of Child Health and Human Development (NICHD), 2005; Storch & Whitehurst, 2002). Specifically, in addition to letter knowledge and receptive vocabulary, further pre-reading skills that are prerequisite for children's early reading development include phonological awareness and print knowledge (Evans & Shaw, 2008).

Phonological awareness (PA) plays a crucial role in learning to read (Melby-Lervåg, Lyster, & Hulme, 2012), but its relationship with preschool home literacy practices is not clear. Sénéchal and LeFevre (2002) found no direct relationship between either storybook exposure or parental teaching and later PA skills, although PA did uniquely contribute to receptive vocabulary. Hood et al. (2008) also failed to find a direct link between the HLE and PA, when the measure of PA included both rime and phoneme awareness; however post hoc analysis did reveal a weak association ($r = .19$) between the storybook exposure and rime component. Stephenson, Parilla, Georgiou and Kirby (2008) also failed to find a relationship between parental teaching and phonological sensitivity, but they suggested that this might have been due to not including questions concerning the parent's teaching of rhyming.

Other studies have found significant relationships between HLE and different aspects of PA (Evans et al., 2000; Foy & Mann, 2003; Wood, 2002). Foy and Mann (2003) found that exposure to children's literature was directly related to rime awareness skills and parent teaching was directly related to phoneme awareness. Evans et al. (2000) also found that parent teaching was a significant predictor of phonemic awareness. These findings are consistent with the theory, proposed by Hulme and colleagues (Hulme, Boywer-Crane, Carroll, Duff, & Snowling, 2012; Hulme et al., 2002), that rime awareness and phonemic awareness, both considered to be phonological skills, are separate constructs (although linked on a developmental pathways where rime awareness develops first) and phonemic awareness is the better predictor of word reading skills. For the current study, with three to four year-old children, we aimed to measure both rime and phonemic aspects of phonological awareness.

The relationship between print knowledge and storybook exposure is also unclear. Mol and Bus (2011) found in their meta-analysis of 29 parent-child storybook exposure studies (through preschool and kindergarten) that storybook exposure explained about 10% – 12% of children's language and 8% of children's basic reading skills. However, other studies have specifically examined the degree to which children attend to the form of the print during shared reading (Ezell & Justice, 2000; Levy et al., 2006). These studies concluded that children rarely look at the print during shared book reading and, as such, do not increase their print knowledge during these informal activities.

Mol and Bus (2011) included studies with children aged two to six years, and other studies have suggested that the relationships between home literacy practices and developing literacy skills may change during this period (Evans, Moretti, Shaw, & Fox, 2003; Ezell & Justice, 2000). Also there is some blurring between formal and informal aspects of print activities (Evans & Shaw, 2008). Storybooks can be shared for enjoyment and meaning, whilst, simultaneously, focusing on the print (Justice & Ezell, 2002). More explicit coaching of print awareness during shared book reading increases from preschool through kindergarten to Grade 1 (Evans et al., 2003; Sénéchal & LeFevre, 2014).

Additionally, parent teaching changes over time; parents adjust their teaching to their children's skill levels once they have begun formal schooling (Hood et al., 2008; Silinskas, Leppänen, Aunola, Parrila, & Nurmi, 2010). At the beginning of the current study, children were three to four years old; however they were attending a Nursery class, situated in a primary school, in preparation for fulltime education the following academic year. Although formal literacy instruction did

not begin during the nursery year, parents may have adjusted their home literacy practices with their children in preparation for learning to read at school.

The inconsistent results, reported in the literature to date, of research investigating the precursors to reading may possibly be due to varying measures and different age groups employed in the studies. To clarify the relationship between these skills, and their association with home literacy practices and emergent literacy skills, it is crucial to establish the baseline measures of very young non-readers. To address this issue, children in the current study were initially assessed when they were three to four years old. In the UK, these very young children begin their preschool education by attending nursery classes for five half-day sessions per week. Full-time education begins the following year, when they are four to five years old, and formal literacy instruction commences at that time. The children in the current study were beginning the second term of half day pre-school (the first term was considered a 'settling in' period), so the children's baseline levels of the pre-requisite skills were measured before they received any reading-related instruction at school.

3.1.4 The Current Study

This current longitudinal study, based in the UK, aimed to extend the body of HLE research to investigate the effects of home literacy practices on three to four year-old children's baseline measures of pre-reading skills, as they began preschool nursery. Subsequently, the children's emergent literacy skills (single word reading and listening comprehension) were measured a year and a half later, following a year of formal literacy instruction, to replicate and extend the findings

of Sénéchal and LeFevre (2002) relating to the early pathways of their Home Literacy Model. Due to the early commencement of formal literacy instruction in the UK, the children in the current study were only five years old after completing a full year of literacy instruction at school.

The children were first assessed at the beginning of their second term at preschool nursery, when they were three to four years old, and parents completed a HLE questionnaire at this time. All children were non-readers (confirmed by a zero score on a single word reading task). Children were assessed to establish a range of cognitive baseline measures, including the four pre-reading skills (receptive vocabulary, phonological awareness, print knowledge, letter knowledge) considered to be pre-requisite to successful reading (Evans & Shaw, 2008). The first aim was to investigate whether home literacy practices, before children begin schooling, would predict the children's baseline measures of the pre-reading skills. A second aim, based on the early pathways of the Home Literacy Model (Sénéchal & LeFevre, 2002), was to examine the direct and indirect pathways from preschool home literacy practices to later emergent literacy (aged five years). However, in contrast to Sénéchal and LeFevre (2002), the children in this study, at five years old, had completed a full year of formal literacy instruction.

The final aim of the current study was to augment the information regarding the quality of children's home literacy experiences. In addition to requesting a parental report of the child's interest in being read to, parents were also asked to rate children's behaviour during shared book reading. Previous research has found that the social-emotional quality of the parent-child interaction during

shared book reading was related to vocabulary development, but not decoding skills (de Jong & Leseman, 2001). Also, an intervention study with three to four year olds (Blewitt et al., 2009) found that extra textual comments and questions from an adult during and after shared book reading contributed to vocabulary growth. Therefore, using parent report, the aim was to investigate children's engagement during shared book reading and how it may contribute to vocabulary growth and emergent literacy skills.

Based on the Home Literacy Model, the frequency of parental teaching was expected to directly relate to children's baseline letter knowledge and storybook exposure directly relate to children's baseline receptive vocabulary. In previous research (Hood et al., 2008; Sénéchal & LeFevre, 2014; Sénéchal & LeFevre, 2002), relationships between these variables have become indirect once the children experienced formal literacy instruction, however, in this study, although the children had completed a year of literacy instruction, they were still young (mean age = 5:02 years, SD = 4 months). Therefore, it could not be predicted whether relationships between preschool home literacy practices and later emergent literacy at the end of the reception year would be direct or indirect via children's baseline cognitive abilities. Parental teaching was expected to directly relate to single word reading and storybook exposure to relate to listening comprehension. The ambiguous relationships, reported in the literature, between home literacy practices and both PA and print exposure meant clear predictions were difficult to make, although both formal and informal home literacy were expected to contribute to both skills. It was expected that the novel measure of quality of engagement would directly relate to receptive vocabulary and later listening comprehension.

3.2 Method

3.2.1 Participants

At Time 1 (T1) the sample comprised of 83 preschool children (39 boys and 44 girls; mean age 3:10 years, SD = 3.5 months) attending the Nursery class of two mainstream primary schools in South East England (see 2.4 for further details). The children were recruited during their first term at nursery and were initially assessed at the beginning of the second term (Time 1). At this stage the children attended school for five three-hour sessions per week (45 attended morning sessions; 38 attended afternoon sessions). There was no formal literacy instruction given during this educational year; however the children experienced games to promote phonological awareness and were often read to. Home literacy questionnaires were sent home to parents at the end of the first academic term. Questionnaires were returned, at the beginning of the second term, for the 83 children in the current study.

Sixty-eight children (32 boys and 36 girls; mean age 5:02 years, SD = 3.6 months) were available for retesting, 16 months later, at the end of their reception year (Time 2). The attrition rate from Nursery to Reception was 18%, which compares favourably to other similar longitudinal studies, which have reported attrition rates of over 26% (Hood et al., 2008). At Time 2, children had all completed one year of formal literacy instruction.

3.2.2 Materials and Measures

Brief descriptions of materials and measures for each time point are given below. For further, more comprehensive details of the materials and scripts for administration refer to Chapter 2.

3.2.2.1 Home Literacy Environment

3.2.2.1.1 Parental questionnaire

Parents were requested to respond to items relating to the frequency of reading related activities using Likert scales. Items included frequency of reading to their child at bedtimes and at other times during the day, frequency of their child asking to be read to and frequency of library visits. Parents were also asked to estimate the number of children's books at home and the age of their child when they started reading to them. Three further items asked about the frequency of parental teaching of literacy skills. Using a five point Likert scale, parents were asked to report the frequency of teaching their child to write words, read words and how often they played rhyming games (see Appendix 11 for HLE questionnaire). These questions were based on HLE questionnaires used in previous studies (Hood et al., 2008; Sénéchal et al., 1998). Additionally, to assess the quality of shared reading, parents were asked to report, using a five point Likert scale, the frequency of their child's active engagement *during* storybook reading for six measures: name pictures, point at letters/words, read aloud letters/words, ask the meaning of words, comment on the story, guess the ending of the story. The questionnaire also included a range of non-literacy items, e.g., frequency of television and computer usage, frequency of extracurricular

activities and questions relating to family structure and parents' education and occupation.

3.2.2.1.2 Child Title Recognition Task

For this study a Title Recognition Task (TRT) was administered directly to the children. The task consisted of 15 titles of popular children's storybooks (selected from UK online retailers' best seller lists) and 15 foils (see Appendix 5). The researcher explained to the child that they would hear the names of storybooks; some of the books they would know and some they would not know because they were for "grown-ups". The researcher then presented each title and the child responded "yes" or "no". During the task the child was again reassured that they were not expected to know all the titles. As in previous studies, the procedure for scoring the TRT was to subtract the number of selected foils from the number of correctly selected genuine titles (Hood et al., 2008; Farver, Xu, Eppe & Lonigan, 2006; Sénéchal et al., 1998).

3.2.2.2 Time 1 (T1): Nursery (spring term)

3.2.2.2.1 Nonverbal ability

The Block Design subtest of The Wechsler Preschool and Primary Scale of Intelligence – III (WPPSI-III) (Wechsler, 2002) was used to measure children's non-verbal ability. Scaled scores were used and the maximum score was 19.

3.2.2.2.2 Receptive vocabulary

The children's receptive vocabulary was assessed using the British Picture Vocabulary Scale: 2nd Edition (Dunn, Dunn, Whetton, & Burley, 1997). The maximum score was 84.

3.2.2.2.3 Phonological awareness

To assess the children's phonological awareness, two subtests of the Phonological Abilities Test (PAT; Muter, Hulme, & Snowling, 1997) were used: Rhyme Detection subtest and Word Completion subtest. The maximum scores were 10 for Rhyme Detection and 16 for Word Completion.

3.2.2.2.4 Print knowledge

The Print Knowledge subtest of the Test of Preschool Early Literacy (TOPEL) (Lonigan, Wagner, Torgeson, & Rashotte, 2007) was used to measure the children's print knowledge. The maximum score was 12.

3.2.2.2.5 Letter knowledge

The Alphabet Knowledge subtest of the PAT (Muter et al., 1997) was used to establish the children's letter knowledge. The children were presented with each letter of the alphabet printed individually on a card, and asked to give the name and/or sound of that letter. The maximum score was 26.

3.2.2.3 Time 2 (T2): Reception (end of summer term)

3.2.2.3.1 Single word reading

The Early Word Recognition subtest of the York Assessment of Reading for Comprehension (YARC; Snowling et al., 2011) was used to assess emergent single word reading skills. The maximum score was 30.

3.2.2.3.2 Listening comprehension

Stories taken from the Neale Analysis of Reading Ability (NARA; Neale, 1997) were used to assess the children's listening comprehension. For each story the accompanying black and white illustration was placed in front of the child and the researcher read the story. The child did not see the text. Following each story, the researcher asked the comprehension questions. The stories were presented in sequence, as they increase in length and difficulty, until the child failed to correctly answer any of the comprehension questions. The maximum score was 24. Standardized reading comprehension tests have been used to measure listening comprehension in previous research (Nation, Cocksey, Taylor, & Bishop, 2010).

3.2.3 Procedure

3.2.3.1 Home Literacy Environment

Informed (opt-in) consent was obtained from the head teachers of the schools. Detailed information about the longitudinal study was sent home to parents, including an 'opt out' consent form. A parental-report HLE questionnaire was sent home via the classroom teachers. In addition to items relating to literacy at home, the questionnaire requested parental report of family structure and social

economic status. The child-administered title recognition task (TRT) was included in children's T1 assessments at school.

3.2.3.2 Time 1 (T1)

Children were tested individually in a quiet area immediately outside of their classroom. Each child completed four 15 to 20 minute sessions administered by one of four researchers. All assessment sessions were counterbalanced. See 2.5.2 for further details.

3.2.3.3 Time 2 (T2)

The children were retested at the end of the reception year. Children completed two test sessions of 15 to 20 minutes, in a quiet area outside of their classroom. Assessment sessions and tasks within the session were counterbalanced. See 2.5.4 for further details.

3.3 Results

3.3.1 HLE: Literacy practices at home

Results from the home literacy environment questionnaire showed that all parents reported reading to their children at least once a day. Bedtime reading was the most frequent with 71.4% of parents reporting that they read to their child every night. There was greater variance in the reports of reading at other times of the day ranging from once a week (1.2%) to more than seven times a week (8.3%) with a mean of 4.5 (SD = 1.94) times a week. The majority of parents (73.8%) reported that their child often or very often requested shared reading,

with only two parents reporting that their child seldom requested to be read to. A total of 29.7% reported that their child visits the library often/very often, with only thirteen parents (15.5%) reporting that their child never visits the library. All parents reported having children's books available in their home, with 70.3% estimating that they have more than 60 books.

Many parents reported that they taught their children to write words e.g., their own name (77.4%) and read words (64.3%) sometimes or often. Most parents reported at least sometimes playing rhyming games with their child (79.7%). The items relating to the child's engagement during storybook reading suggested that most children are engaged during shared reading. Parents reported that their child named pictures (94.1%), pointed at letters/words (58.3%) and commented on the story (84.5%) often or very often during shared reading. Only one parent reported that their child never commented on the story and three parents reported that their child never pointed at letters or words during shared reading. Full details of parents' responses to the HLE questionnaire can be found in Appendix 11.

3.3.2 Preliminary analyses

The descriptive statistics for preschool home literacy factors, T1 preschool child measures and children's later emergent reading ability at T2 are reported in Table 3.1. Distributions for all variables were acceptable, with the exception of a significant positive skew observed in T1 letter knowledge. Further investigation revealed that 43.9% of the children knew no more than 2 letters sounds, reflecting the fact that these young children had not begun formal education. A

square root transformation was performed to normalize the positive skew and the transformed variable was used in the analysis.

Table 3.1

Means and standard deviations for HLE measures and key variables at T1 and T2

Measure	Max	M	SD	Range
HLE measures				
Bedtime reading (frequency)	7	6.24	1.50	0 - 7
Other time reading (frequency)	8	4.46	1.91	1 - 8
Child interest (request to be read to)	5	4.09	0.83	2 - 5
Library visits (frequency)	5	2.87	1.12	1 - 5
Number children's books at home (categories)	5	3.90	1.11	1 - 5
Parent teaching (frequency)				
- Write words	5	3.37	0.93	1 - 5
- Read words	5	3.23	1.06	1 - 5
- Rhyming games	5	3.42	1.15	1 - 5
Child narrative engagement				
- Name pictures	5	4.37	0.76	2 - 5
- Point at words	5	3.69	1.05	1 - 5
- Say words aloud	5	3.23	1.06	1 - 5
- Ask meaning of words	5	3.27	1.04	1 - 5
- Comment on story	5	4.31	0.81	1 - 5
- Guess end of story	5	3.20	1.20	1 - 5
- Retell story	5	3.60	1.13	1 - 5
Title Recognition Task	15	3.68	2.59	0 - 10
T1				
Age (yrs:mths)	-	3:10	0:04	3:05 - 4:05
Nonverbal ability ^a	19	12.41	3.05	4.00 - 18.00
Receptive vocabulary	84	47.18	10.65	23.00 - 71.00
Phonological awareness				
- Rhyme detection	10	5.29	3.06	0 - 10
- Word completion	16	5.95	3.06	0 - 15
Print knowledge	12	5.89	2.59	1.00 - 12.00
Letter knowledge	26	8.23	8.05	0.00 - 25.00
T2				
Age (yrs:mths)	-	5:02	0:04	4:09 - 5:09
Single word reading	30	14.26	7.56	1.00 - 30.00
Listening comprehension	24	10.41	4.51	1.00 - 20.00

Note: ^a Standard score; T1 = Time 1 (Nursery); T2 = Time 2 (end of Reception); HLE = Home literacy environment

A composite measure was computed for phonological awareness (sum of PAT rhyme detection and word completion subtests). Initial correlation analysis was

conducted with both independent phonological awareness measures. However, subsequent zero order correlations revealed the same pattern of significant relations when using the composite measure. Therefore, in order to reduce the number of control variables, the composite was used in the following regression analyses.

3.3.3 Principal component analysis

A factor analysis was conducted to determine home literacy factors. Children's interest in reading was measured by a single item; therefore it was not included in the factor analysis. To reduce the number of items, bedtime reading and other time reading were summed to give an overall composite for frequency of shared book reading. Shared book reading, the remaining twelve items relating to home literacy from the HLE questionnaire and the child administered Title Recognition Task were included in the factor analysis.

A principal components analysis (PCA) was conducted on the fourteen items with orthogonal rotation (varimax). This method of factor rotation was chosen to replicate previous literature that has used PCA with orthogonal rotation (varimax) to determine variables underlying the distinct HLE practices of shared book reading and parental teaching (Hood et al., 2008; Sénéchal & LeFevre, 2002). The Kaiser-Meyer-Olkin measure verified good sampling adequacy for the analysis, $KMO = .71$, and Bartlett's test of sphericity $X^2(55) = 236.32, p < .001$ indicated that correlations between items were sufficiently large for PCA (Field, 2009). An initial analysis was run to obtain eigenvalues for each component in the

¹ Correlation analysis of the factors revealed that Parental Teaching and Child Narrativ¹³⁶

data. Three items (number of books, teach rhyming and ask meaning of words) were excluded as the factor loadings were low ($< .5$) and they did not clearly load on any of the factors. As a consequence, a second analysis was conducted with the remaining measures¹.

Table 3.2

Principal Components Analysis of items measuring the Home Literacy Environment (N = 83)

Item	Factor Loadings		
	Storybook Exposure	Parent Teach	Child Narrative
Engagement			
TRT	.70	.04	.04
Library visit frequency	.73	.18	-.16
Shared book reading frequency	.77	-.14	-.10
Teach write words frequency	.09	.74	.00
Teach read words frequency	.27	.72	.16
During read point at words frequency	-.13	.79	.29
During read say words aloud frequency	-.09	.69	.09
During read comment on story frequency	.11	.22	.73
During read name pictures frequency	-.05	.19	.60
During read guess ending frequency	.02	-.01	.86
During read retell story frequency	-.05	.06	.85
Eigenvalues	1.62	1.83	3.11
Percentage of variance	14.70	16.63	28.24
Kaiser-Meyer-Olkin measure	.71		
Bartlett's test of sphericity	$\chi^2(55) = 236.32, p < .001$		
Cronbach's α	.65	.75	.77

Notes: TRT = Title recognition task

The three factors in total explain 59.92% of variance. Composite measures were formed for each of the three factors.

¹ Correlation analysis of the factors revealed that Parental Teaching and Child Narrative Engagement were significantly correlated, therefore PCA was also re-run using oblique rotation (direct oblimin). The pattern of results was the same. Three components were indicated, accounting for 59.81% of variance. The same items, as shown in Table 3.2, clustered on each of the three components and factor loadings were very similar.

For Storybook Exposure the three loaded items were standardized and summed (see Hood et al., 2009). Four items loaded on the Parent Teaching factor and each used the same Likert scale; therefore values were summed to form a composite score. There were also four items for the Child Narrative Engagement factor and, once again, the same Likert scale was used and these items were summed for the composite score. The three composite scores, along with the single measure of Child Interest in Reading (frequency of child asking to be read to) were the four HLE measures used in the following analyses.

Correlational Analysis

Zero order correlations between variables at T1 and T2 can be found in Table 3.3. Significant correlations ($r = .29$ to $.41$, *all ps* < .01) were found between non-verbal ability and each of the four prerequisite literacy skills (receptive vocabulary; phonological awareness; print knowledge; letter knowledge). Age (at time of testing) was significantly related to receptive vocabulary and PA ($r = .31$ and $.31$, *ps* < .01), but not to print knowledge or letter knowledge. Significant correlations ($r = .43$ to $.62$, *all ps* < .01) were also found between the four pre-reading skills.

At T2, single word reading and listening comprehension were significantly correlated ($r = .31$, $p < .01$). Age at T2 was significantly correlated with listening comprehension ($r = .27$, $p < .05$), but not single word reading ($r = .16$, *ns*).

Longitudinally, as expected, storybook exposure significantly correlated with listening comprehension ($r = .42$, $p < .001$); however it also significantly correlated with single word reading ($r = .34$, $p < .01$). Parental teaching

significantly related to single word reading ($r = .39, p < .01$), but the relationship with listening comprehension was not significant ($r = .07, ns$). Children's interest in reading significantly correlated with both single word reading and listening comprehension ($r = .28$ and $.29, p < .05$ respectively); however, children's engagement during storybook reading did not significantly correlate with either of the T2 measures. Moderate to strong significant correlations were found between all four of the T1 pre-reading skills and both T2 single word reading and listening comprehension ($r = .33$ to $.68, all ps < .01$).

Table 3.3:
Zero-order correlations between preschool (T1) variables (HLE and pre-reading skills) and children's single word reading and listening comprehension at T2

	1	2	3	4	5	6	7	8	9	10	11	12	13
T1 Control variables (Preschool)													
1. Age													
2. Non Verbal	-.02												
3. Parent's Education	-.01	-.01											
T1 Home Literacy (Preschool)													
4. Storybook Exposure	-.04	.29**	.29**										
5. Parent Teaching	.02	.11	.05	.08									
6. Child Narrative Engage	-.13	-.08	.13	.01	.31**								
7. Child Interest	-.01	.19	.25*	.33**	.05	-.14							
T1 Pre-literacy skills (Preschool)													
8. Receptive vocabulary	.31**	.41***	.17	.44***	.04	-.09	.07						
9. Phonological Awareness	.31**	.35**	.18	.42***	.12	-.07	.09	.52***					
10. Print knowledge	.03	.37**	.19	.31**	.30**	.00	.13	.47***	.52***				
11. Letter knowledge	.14	.29**	.15	.39***	.35**	.01	.11	.43***	.62***	.56***			
T2 Emergent literacy (Reception)													
12. Age (T2)	.99	.06	.03	-.01	-.09	-.14	-.04	.42***	.42**	.15	.16		
13. Single word reading	.16	.30*	.13	.34**	.39**	.13	.28*	.33**	.56***	.35**	.68***	.16	
14. Listening Comprehension	.27*	.17	.21	.42***	.07	-.01	.29*	.48***	.39**	.33**	.33**	.27*	.31**

Notes: * $p < .05$; ** $p < .01$; *** $p < .001$; T1 = Time 1; T2 = Time 2

3.3.4 Home literacy and preschool abilities

To further examine the relationships between home literacy practices and pre-reading cognitive skills, a series of hierarchical regression analyses were conducted with the aim of investigating the degree to which the home literacy environment factors (storybook exposure and parental teaching) predicted each of the four proposed pre-reading skills: receptive vocabulary, phonological awareness, print awareness (PA) and letter knowledge. Child interest was not included in these regression analyses, as it did not significantly correlate with any of the pre-reading skills.

In order to control for the effects of age and in preparation for the regression analyses all variables were residualised for age (see 2.6 for rationale). The exception was non-verbal ability, where standard scores had been used. For each analysis, one of the pre-reading skills was the criterion variable, and non-verbal ability and the remaining three pre-reading skills were entered at Step 1. The home literacy measures were entered at Step 2, with the proviso that each of the predictors was significantly correlated with the criterion (otherwise they were excluded from the analysis).

3.3.4.1 Predicting preschool (T1) receptive vocabulary

Hierarchical regression analysis was carried out to investigate the degree to which storybook exposure accounted for unique variance in receptive vocabulary. Results of this analysis are reported in table 3.4. Exploration of standardized residual statistics after each step in the regression revealed normal distribution

and no outliers. Analysis revealed that with all variables entered in the equation, the model was significant, $F(5, 77) = 10.12, p < .001$ with a total R^2 value of .40.

Table 3.4:
Hierarchical regression analysis predicting preschool receptive vocabulary at age 3

Variable	ΔR^2	$B (SE B)$	β	p
Outcome variable: Preschool receptive vocabulary ($N = 83$)				
<i>Step 1</i>	.34*			
Nonverbal ability		0.27 (.10)	.27	.010*
PA		0.24 (.12)	.24	.058
Print knowledge		0.21 (.12)	.21	.069
Letter knowledge		0.04 (.12)	.04	.775
<i>Step 2</i>	.06*			
Nonverbal ability		0.08 (.03)	.24	.019*
PA		0.15 (.12)	.15	.217
Print knowledge		0.20 (.11)	.20	.074
Letter knowledge		-0.01 (.12)	-.01	.955
Storybook exposure		0.12 (.05)	.27	.009*
Total $R^2 = .40^*$; $F(5, 77) = 10.12, p < .001$				

Note: * $p < .05$; PA = phonological awareness

At Step 1, T1 non-verbal ability, PA, print knowledge and letter knowledge together accounted for more than a third of variability on preschool receptive vocabulary. Examination of the coefficients revealed that non-verbal ability was the only significant unique predictor of preschool reading vocabulary. The three remaining pre-reading skills did not uniquely contribute to receptive vocabulary, suggesting shared variance between the skills, however, the unique contributions from PA and print knowledge were marginally significant.

Entering storybook exposure at the final step further improved the model, accounting for a significant unique contribution of 6% of the variance in preschool receptive vocabulary. Examination of the coefficients revealed that, in addition to

storybook exposure, non-verbal ability remained a significant predictor. Parental teaching did not significantly correlate with receptive vocabulary and was not included in the analysis.

3.3.4.2 Predicting preschool (T1) phonological awareness

Hierarchical regression analysis was conducted to examine the level to which storybook exposure accounted for unique variance in phonological awareness (PA). Correlational analysis revealed that preschool PA and parental teaching were not significantly correlated; therefore parental teaching was excluded from the analysis. Results of the analysis are reported in Table 3.5.

Table 3.5:
Hierarchical regression analysis predicting preschool phonological awareness at age 3

Variable	ΔR^2	<i>B</i> (<i>SE B</i>)	β	<i>p</i>
Outcome variable: Preschool phonological awareness (<i>N</i> = 83)				
<i>Step 1</i>	.47*			
Nonverbal ability		0.10 (.09)	.10	.296
Receptive vocabulary		0.19 (.10)	.19	.058
Print knowledge		0.16 (.11)	.16	.138
Letter knowledge		0.43 (.10)	.43	< .001*
<i>Step 2</i>	.02			
Nonverbal ability		0.09 (.09)	.09	.341
Receptive vocabulary		0.13 (.10)	.13	.217
Print knowledge		0.16 (.10)	.16	.137
Letter knowledge		0.39 (.10)	.39	< .001*
Storybook exposure		0.08 (.04)	.17	.073
Total R^2 = .49*; $F(5, 77) = 14.96, p < .001$				

Notes: * $p < .05$

After each step, exploration of standardized residuals and influence statistics revealed normal distribution and no outliers. The final model was significant $F(5,$

77) = 14.96, $p < .001$ and a total R^2 value of .49 suggested that almost half of variability in preschool PA was predicted by the combination of T1 non-verbal ability, receptive vocabulary, print knowledge, letter knowledge and exposure to storybooks. The model at Step 1, after entering non-verbal ability and the remaining pre-reading skills, accounted for a significant 47% of variance in preschool PA. Inclusion of storybook exposure at Step 2 resulted in a small and non-significant change in R^2 of 2%.

Examination of the coefficients revealed that only letter knowledge was a significantly unique predictor of PA. Inspection of the semi-partial correlations produced by the regression revealed that T1 letter knowledge accounted for 10% of variance. Receptive vocabulary, print knowledge and non-verbal ability were not significant unique predictors of PA. Storybook exposure was marginally significant ($p = .07$); however, when considered in combination with the non-significant correlation between parental teaching and PA, this study appears to support previous research in finding no significant direct pathway from home literacy practices to PA.

3.3.4.3 Predicting preschool (T1) print knowledge

Hierarchical regression analysis was carried out to investigate the degree to which both storybook exposure and parental teaching accounted for unique variance in preschool print knowledge. The two home literacy factors were entered together at the final step of the analysis. Initial exploration of the standardized residuals

and influence statistics revealed normal distribution and no outliers. The results of the analysis are reported in table 3.6.

Table 3.6:
Hierarchical regression analysis predicting preschool print knowledge at age 3

Variable	ΔR^2	<i>B</i> (<i>SE B</i>)	β	<i>p</i>
Outcome variable: Preschool print knowledge (<i>N</i> = 83)				
<i>Step 1</i>	.40*			
Nonverbal ability		0.12 (.10)	.12	.244
Receptive vocabulary		0.20 (.11)	.20	.069
PA		0.18 (.12)	.18	.138
Letter knowledge		0.32 (.11)	.32	.006*
<i>Step 2</i>	.02			
Nonverbal ability		0.10 (.10)	.10	.305
Receptive vocabulary		0.23 (.11)	.23	.045*
PA		0.20 (.12)	.20	.110
Letter knowledge		0.26 (.12)	.26	.036*
Storybook exposure		-0.01 (.05)	-.02	.850
Parent teach		0.16 (.09)	.16	.090
Total R^2 = .42*; $F(6, 76) = 9.17, p < .001$				

Notes: * $p < .05$; PA = phonological awareness

Analysis revealed that with all variables entered in the equation, regression for the model was significant, $F(6, 76) = 9.17, p = < .001$. The total R^2 value suggested that 42% of variance in preschool print knowledge was predicted by T1 non-verbal ability, receptive vocabulary, PA, letter knowledge and the home literacy practices of exposure to storybooks and parental teaching.

At Step 1, after entering non-verbal ability and the remaining pre-reading skills, the model accounted for 40% of variance. Inclusion of the home literacy factors at the final step resulted in a small and non-significant change in R^2 . Evaluation of the

coefficients revealed that both receptive vocabulary and letter knowledge accounted for small, but significant, unique variance in preschool print knowledge (inspection of the semi-partial correlations revealed a unique contribution of 3% and 4% respectively). PA and non-verbal ability did not make significant unique contributions. Neither of the home literacy practices: storybook exposure and parental teaching, accounted for unique variance in preschool print knowledge.

3.3.4.4 Predicting preschool (T1) letter knowledge

Hierarchical regression analysis was carried out to investigate the degree to which both storybook exposure and parental teaching accounted for unique variance in preschool letter knowledge. The standardized residuals showed a normal distribution and no outliers were identified. Results of this analysis are reported in Table 3.7. Analysis revealed that with all variables entered in the equation, regression for the model was significant, $F(6, 76) = 12.53, p < .001$. A total R^2 value of 50% suggested that half the variability in preschool letter knowledge was predicted by the combination of T1 non-verbal ability, receptive vocabulary, PA, print knowledge and the home literacy practices.

The model, after entering non-verbal ability and the remaining three pre-reading skills at Step 1, accounted for 45% of variance in preschool letter knowledge. At Step 2, both home literacy practices were entered and, together, they accounted for an additional, significant, 5% of variance.

Table 3.7:
Hierarchical regression analysis predicting preschool letter knowledge at age 3

Variable	ΔR^2	<i>B</i> (<i>SE B</i>)	β	<i>p</i>
Outcome variable: Preschool letter knowledge (<i>N</i> = 83)				
<i>Step 1</i>	.45*			
Nonverbal ability		0.02 (.10)	.02	.870
Receptive vocabulary		0.03 (.10)	.03	.775
PA		0.45 (.10)	.41	< .001*
Print knowledge		0.29 (.10)	.29	.006*
<i>Step 2</i>	.05*			
Nonverbal ability		< 0.01 (.03)	-.01	.976
Receptive vocabulary		0.04 (.11)	.04	.744
PA		0.41 (.11)	.45	< .001*
Print knowledge		0.22 (.10)	.22	.036*
Storybook exposure		0.05 (.04)	.11	.272
Parent teach		0.21 (.09)	.21	.018*
Total R^2 = .50*; $F(6, 76) = 12.53, p < .001$				

Notes: * $p < .05$; PA = phonological awareness

Investigation of the semi-partial correlations produced by the regression revealed that PA was the strongest predictor of preschool letter knowledge, accounting for a significant 10% of unique variance. Print knowledge also accounted for small, but significant, unique variance of 3%. Receptive vocabulary and non-verbal ability were not significant unique predictors. Of the home literacy practices, storybook exposure was not a significant predictor; however, parental teaching did significantly account for unique variance, predicting 4% of variability in preschool letter knowledge.

3.3.5 Home literacy practices and child engagement and interest

The composite measure of child narrative engagement aimed to quantify the level of engagement during shared book reading. Results showed a significant correlation between child narrative engagement and parental teaching ($r = .31, p <$

.01), but not with storybook exposure or child interest ($r = .01$ and $-.14$, *ns* respectively). No further significant relationships were found between the measure and any of the preschool or reception outcome measures, therefore no further analysis was conducted.

Children's interest in reading was measured through parental report. The HLE questionnaire asked parents to report the frequency that their child requested to be read to. Concurrent results showed a significant correlation between child interest and storybook exposure ($r = .33$, $p < .01$); however, there was no significant relationship between child interest and parental teaching or child interest and the pre-reading skills. Longitudinally, child interest significantly correlated with T2 listening comprehension and, in contrast to previous research (Hood et al., 2008), a modest correlation ($r = .28$, $p < .05$) was also found between child interest and word reading at the end of the reception year. Hierarchical regression analyses were carried out to investigate the degree to which child interest accounted for unique variance in later single word reading and listening comprehension. The results of this analysis are reported in Tables 3.8 and 3.9 respectively, and discussed further in the section below.

3.3.6 Home literacy practices and later emergent literacy (T2)

Correlation analysis (see Table 3.3) demonstrated significant longitudinal relations between the preschool home literacy measures (T1) and both measures of emergent literacy (single word reading and listening comprehension) at end of the children's reception year (T2). All three preschool home literacy measures

significantly correlated with later single word reading: storybook exposure ($r = .34, p < .01$), parental teaching ($r = .39, p < .01$) and child interest ($r = .28, p < .05$); however, only storybook exposure ($r = .48, p < .01$) and child interest ($r = .29, p < .01$) significantly correlated with later listening comprehension. There was no significant correlation between parental teaching and listening comprehension ($r = .07, ns$). Moderate to high, significant correlations were also found between the four preschool pre-reading skills and both listening comprehension and single word reading at T2. There was also a significant relationship between the two emergent literacy measures ($r = .31, p < .01$).

To examine these relationships further, hierarchical regression analyses were conducted to investigate the degree to which the home literacy measures accounted for unique variance in later single word reading (Table 3.8) and listening comprehension (Table 3.9), after controlling for T1 non-verbal ability and T1 pre-reading skills (receptive vocabulary, phonological awareness, print knowledge and letter knowledge) at Step 1. The home literacy measures were entered at the final step. All three HLE measures (child interest, storybook exposure and parent teach) were entered for the single word reading analysis; however, as previous correlation analysis had shown no significant relationship between parental teaching and listening comprehension, parental teaching was excluded from the second analysis.

3.3.7 Predicting single word reading

Hierarchical regression analysis was conducted to investigate the degree to which T1 home literacy measures accounted for unique variance in T2 single word reading. Results of this analysis are reported in Table 3.8. Standardized residuals showed normal distribution and no outliers were identified. With all variables added to the equation, analysis showed that the model was significant, $F(8, 59) = 10.80, p = < .001$. A total R^2 value of .59 suggested that more than half of variability in T2 single word reading was predicted by non-verbal ability, T1 pre-reading skills and home literacy practices.

Table 3.8:
Hierarchical regression analysis predicting Reception single word reading at age 5

Variable	ΔR^2	$B (SE B)$	β	p
Outcome variable: Reception single word reading ($N = 68$)				
<i>Step 1</i>	.51*			
Nonverbal ability		0.15 (.10)	.15	.150
Receptive vocabulary		-0.04 (.11)	-.03	.748
PA		0.22 (.12)	.22	.071
Print knowledge		-0.09 (.11)	-.09	.429
Letter knowledge		0.59 (.12)	.56	< .001*
<i>Step 2</i>	.08*			
Nonverbal ability		0.11 (.10)	.11	.270
Receptive vocabulary		0.03 (.11)	.03	.796
PA		0.23 (.12)	.23	.047*
Print knowledge		-0.13 (.10)	-.13	.212
Letter knowledge		0.53 (.12)	.51	< .001*
Child interest		0.21 (.09)	.21	.019*
Storybook exposure		-0.03 (.05)	-.07	.491
Parent teach		0.21 (.09)	.21	.024*
Total $R^2 = .59^*$; $F(8, 59) = 10.80, p < .001$				

Notes: * $p < .05$; PA = phonological awareness

The addition of non-verbal ability and the four T1 pre-reading skills, at Step 1, resulted in significant model accounting for 51% of variance in T2 single word

reading. Child interest, storybook exposure and parent teach were entered at the final step. Results showed a significant change in R^2 , accounting for an additional 8% of variance in later single word reading.

Further investigation of the semi-partial correlations revealed that T1 letter knowledge was the strongest predictor of T2 single word reading, uniquely predicting 14% variance. T1 PA also uniquely contributed, accounting for a small, but significant 3% of variance. Non-verbal ability, T1 receptive vocabulary and T1 print knowledge did not significantly account for unique variance in single word reading. The contribution from storybook exposure was also non-significant; however, both parental teaching and child interest accounted for significant unique variance in later single word reading, each accounting for a further 4% in variance. The results suggest that both parental teaching at home and children's interest in literacy, before the start of formal education, predict unique variance in single word reading ability at the end of the first year of formal literacy instruction. Additionally, parental teaching contributed indirectly to later single word reading via T1 letter knowledge.

3.3.8 Predicting listening comprehension

A final hierarchical regression model was constructed to investigate the degree to which T1 home literacy measures (storybook exposure and child interest) accounted for unique variance in T2 listening comprehension. Results are reported in Table 3.9. Analysis showed that the final model was significant,

$F(7, 60) = 4.79, p = < .001$, with a total R^2 value of .36. Evaluation of standardized residual and influence statistics showed normal distribution of residuals and no outliers.

Entering non-verbal ability and T1 pre-reading skills at Step 1 yielded a significant model and accounted for a significant 28% of variance in T2 listening comprehension. The model was further improved with the addition of the two home literacy measures at Step 3, accounting for an additional 8% of variance.

Table 3.9:
Hierarchical regression analysis predicting Reception listening comprehension at age 5

Variable	ΔR^2	$B (SE B)$	β	p
Outcome variable: Reception listening comprehension ($N = 68$)				
<i>Step 1</i>	.28*			
Nonverbal ability		-0.12 (.13)	-.12	.343
Receptive vocabulary		0.39 (.13)	.38	.005*
PA		0.17 (.14)	.17	.238
Print knowledge		0.16 (.13)	.16	.225
Letter knowledge		0.03 (.15)	.03	.917
<i>Step 2</i>	.08*			
Nonverbal ability		-0.17 (.12)	-.17	.167
Receptive vocabulary		0.33 (.13)	.32	.015*
PA		0.10 (.14)	.10	.485
Print knowledge		0.17 (.13)	.17	.195
Letter knowledge		-0.02 (.15)	-.01	.919
Child interest		0.17 (.11)	.17	.119
Storybook exposure		0.10 (.06)	.22	.097
Total $R^2 = .36^*$; $F(7, 60) = 4.79, p < .001$				

Notes: * $p < .05$; PA = phonological awareness

Evaluation of the coefficients showed that T1 receptive vocabulary was the only significant unique predictor of T2 listening comprehension. Investigation of the semi-partial correlations revealed that T1 receptive vocabulary accounted for 7%

variance in T2 listening comprehension. Non-verbal ability, T1 PA, print knowledge and letter knowledge did not uniquely predict T2 listening comprehension.

The T1 home literacy measures of child interest and storybook exposure, in combination, significantly accounted for 8% variance in T2 listening comprehension, however, neither of the measures accounted for unique variance, suggesting a degree of shared variance. The results suggest that there are no unique direct pathways from storybook exposure or child interest to later listening comprehension, however, the combination of the two home literacy measures did significantly predict variance in listening comprehension, suggesting that preschool home literacy practices involving shared storybook reading may directly contribute to later listening comprehension. Additionally, it may be that the relationship between storybook exposure and later listening comprehension is through an indirect pathway via receptive vocabulary.

3.4 Discussion

The home literacy environment of a group of three to four year-old non-readers was initially investigated to determine how children's exposure to storybooks, experience of parental literacy teaching and their interest in reading related to baseline ability in four pre-reading skills (receptive vocabulary, phonological awareness, print knowledge and letter knowledge) at the beginning of Nursery (pre-school). To explore the longitudinal implications of the children's home literacy experiences, children were reassessed 16 months later, at the end of their

first year of full-time education (Reception), to investigate the relationship between the pre-school home literacy factors and children's emergent word reading and listening comprehension skills.

The current study adds to existing knowledge of the HLE in two ways. The first was to extend the Home Literacy Model (Sénéchal & LeFevre, 2002) to a younger, UK sample of pre-reading children to examine the contribution of home literacy activities to early preschool pre-reading skills. The second was to test the early longitudinal pathways of the Home Literacy Model (Sénéchal & LeFevre, 2002) in a younger sample of children. Children in the UK begin formal literacy instruction at four to five years old, a year younger than many other countries. The Home Literacy Model (Sénéchal & LeFevre, 2002) proposes that for six year olds the influence of home literacy activities becomes indirect after the introduction of formal literacy instruction. The children in the current study had also experienced a year of literacy instruction, but at the final time of testing they were only aged five. Therefore, the current study was able to investigate whether the effects of the HLE become indirect due to the introduction of formal literacy instruction or simply due to maturation. An overall summary of the findings is shown in Figure 3.1.

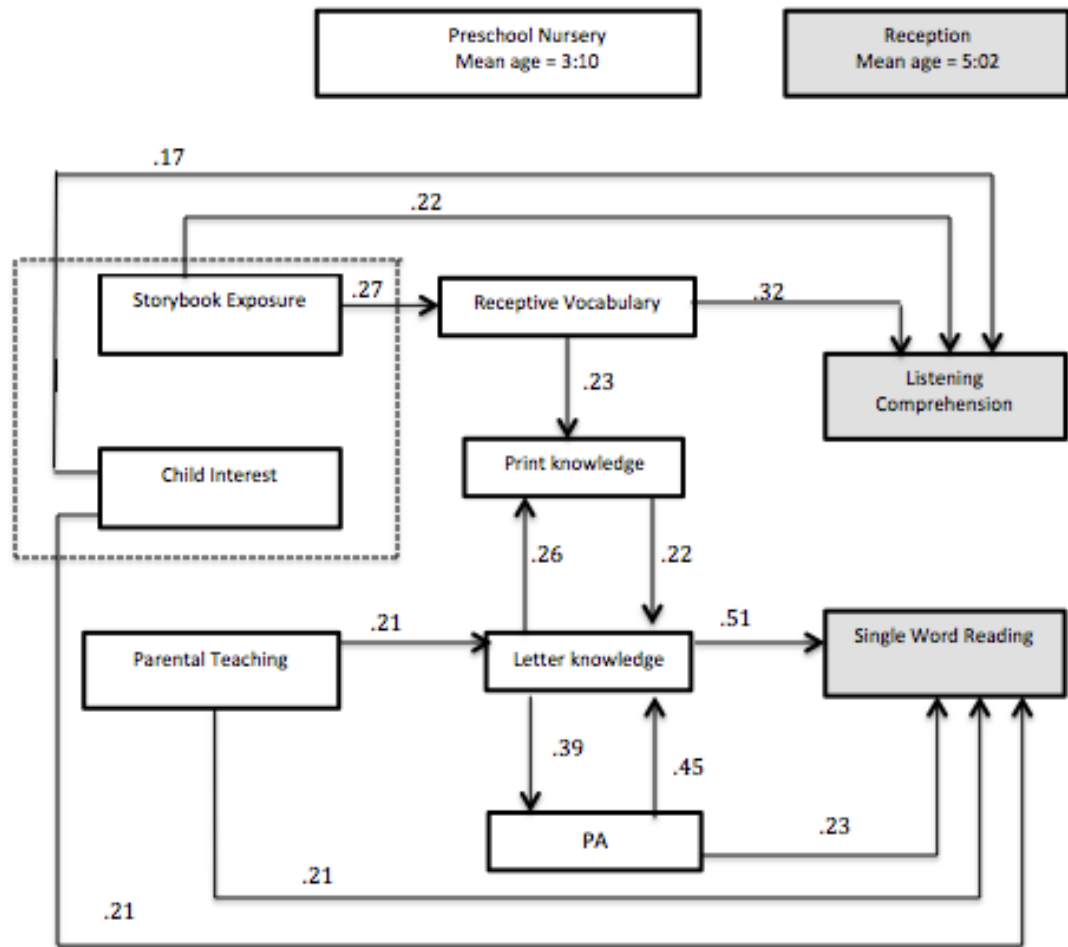


Figure 3.1: Model showing relationships between home literacy practices and pre-reading skills at three years and later emergent literacy skills at five years, controlling for age and non-verbal ability. Notes: values are standardized coefficients from exploratory regression analyses. All pathways are significant at $p < .05$, excluding pathways from Child Interest and Storybook Exposure to Listening Comprehension, however, in combination the two factors uniquely contributed to Listening Comprehension.

Results confirm the Home Literacy Model (Sénéchal & LeFevre, 2002) can be extended to include three-year-old pre-reading children. They show that home literacy practices uniquely predict baseline levels of receptive vocabulary and letter knowledge at the beginning of pre-school, over and above children's age, non-verbal ability, print knowledge and phonological awareness. Additionally, the results confirm that the early direct pathways of the model to emergent word

reading skills remains stable for five year olds, even though they had completed a full year of formal literacy instruction at school.

The frequency of parental teaching of letters and words at home, during the time that children were starting preschool, uniquely contributed to their word reading skills at the end of the reception year. The pathway from HLE to listening comprehension was also significant. Following a year of literacy instruction, there was an indirect pathway from storybook exposure to later listening comprehension via receptive vocabulary. However, there was also a direct pathway; in combination with children's interest in reading, storybook exposure directly contribute to later listening comprehension. Although neither storybook exposure nor children's interest in reading uniquely contributed to listening comprehension, together they accounted for significant 8% of variance, suggesting that preschool 'informal' home literacy practices continue to exert some direct influence on the later language skills of five year olds, after a year of full time education.

3.4.1 Home Literacy Environment

Consistent with the majority of prior studies (Hood et al., 2008; Fritjers et al., 2000; Sénéchal et al., 1996, 1998), most measures for the home literacy environment were taken from a parental, self-report questionnaire. However, in line with a limited number of studies (Davidse et al., 2011; Sénéchal et al., 1996), a child-administered title recognition task was also used to obtain a direct measure of children's storybook exposure. The children came from a middle class

background, with the majority of parents having completed some form of tertiary education. The reported levels of frequency of shared book reading and other storybook exposure measures were, in general, similar to other studies (Haney & Hill, 2004; Hood et al., 2008; Sénéchal et al., 1996). However, the frequency of literacy teaching (to read and write words) was higher than found in other studies of children of similar age (Haney & Hill, 2004), but more consistent with studies of the home literacy environment of five year olds (Hood et al., 2008). It has been reported that literacy practices at home change over time and that parents adapt their teaching practices as children approach the beginning of formal education and through the early years (Evans et al, 2003; Silinskas et al., 2010). Although the children in the current study were beginning half-day pre-school, parents may have considered this to be the beginning of formal schooling and adapted their teaching practices to prepare their children for school.

In the current study, parental teaching was a composite measure of frequency of teaching reading and writing words. However, in line with earlier studies, we used multiple measures to capture a wider range of aspects of storybook exposure (Hood et al., 2008; Fritjers et al., 2000). In addition to parental report of frequency of shared reading, frequency of library visits and a novel child-administered title recognition task (TRT) were also included. The TRT was a direct measure of the children's knowledge of storybooks and significantly correlated with the other measures of storybook exposure and all of the children's outcome measures. Consistent with Sénéchal & LeFevre's model (2002), the composite measures of storybook exposure and of parental teaching shared very little variance and loaded on separate factors, suggesting that they were distinct practices.

3.4.2 Pre-reading skills

Receptive vocabulary, phonological awareness, print knowledge and letter knowledge are all skills thought to be pre-requisites to emergent literacy (Evans & Shaw, 2008). Initially, the relationship between each of these four pre-reading skills and the home literacy factors were examined. The pre-reading skills were all significantly inter-correlated. All four were also moderately correlated with storybook exposure. However, only print exposure and letter knowledge were significantly correlated with parental teaching, there was no significant relationship between parental teaching and either receptive vocabulary or phonological awareness (Foy & Mann, 2003; Sénéchal & LeFevre, 2002).

After controlling for age, non-verbal ability and the remaining three pre-reading skills, storybook exposure was found to account for unique variance in baseline receptive vocabulary, and parental teaching uniquely predicted baseline letter knowledge. Although the children in this study were a year younger, the results are consistent with previous research with kindergarten and Grade 1 children (Evans et al., 2000; Hood et al., 2008; Sénéchal, 2006; Sénéchal & LeFevre, 2002).

The findings add to research to confirm that storybook exposure, including frequency of parent-child shared book reading, and direct parental teachings of literacy are distinct practices at home. Storybook exposure uniquely contributed to growth of receptive vocabulary, but not letter knowledge, and parental teaching accounted for unique variance in letter knowledge, but not receptive vocabulary. In the current analysis, apart from non-verbal ability, storybook exposure was the only literacy-related predictor of receptive vocabulary. However, in addition to

parental teaching, phonological skills and print knowledge also significantly predicted letter knowledge.

Consistent with previous studies with five to six year-old children (Foy & Mann, 2003; Hood et al., 2008; Sénéchal et al, 1998), neither storybook exposure nor parental teaching concurrently predicted baseline phonological awareness (PA). The PA composite measure included a rime aspect and a phonemic aspect, as recent research has suggested that the two aspects are distinct and contribute to different aspects of emergent literacy (Melby-Lervåg et al., 2012). Zero order correlations in the current study showed a similar pattern of significant relationships for both aspects, therefore the two measures were combined to give a richer composite measure. Although the home literacy practices did not significantly contribute to baseline PA, baseline letter knowledge did account for unique variance in this early composite measure of PA, providing evidence for an indirect association between parent teaching and PA via letter knowledge (Foy & Mann, 2003). The results suggest there are no direct pathways from home literacy practices to early PA, although parental teaching is indirectly linked through letter knowledge, with letter knowledge predicting baseline levels of phonological skills. In contrast to Sénéchal & LeFevre (2002), there was no indirect pathway from storybook exposure to PA; vocabulary did not contribute to PA. This may be due to the younger age of the children, as vocabulary may not contribute to PA until it increases in breadth (Metsala, 1999).

Although a significant correlation was found between print knowledge and both storybook exposure and parental teaching, the regression analysis failed to find

any unique contribution from either of the home literacy practices to baseline print exposure after controlling for the children's age, non-verbal ability and the other pre-reading skills. However, both receptive vocabulary and letter knowledge accounted for unique variance in baseline print knowledge, suggesting indirect pathways from storybook exposure via receptive vocabulary and from parental teaching via letter knowledge. The failure to find a direct pathway from storybook exposure is consistent with research that suggests that young children do not pay attention to print during shared book reading (Evans & Shaw, 2008; Ezell & Justice, 2000, Levy et al., 2006). The pathway from parental teaching was stronger, although not significant, which may suggest direct teaching about print would predict early print knowledge. Failure to find a significant pathway may be due to the questions that were asked about parental teaching. Parental teaching was quantified as the frequency of teaching children to read and write words, however, to gain a wider perspective questions should be included to assess direct teaching of print awareness, for example the use of ABC books.

3.4.3 Children's engagement and interest in literacy

A further aim of this study was to investigate the quality of children's engagement during shared book reading. Research has shown that drawing children's attention to print (Levy et al., 2006) and extra-textual comments and questions from parents during shared reading (Blewitt et al., 2009) contribute to additional vocabulary growth and children's engagement in the narrative was expected to result in similar gains. Parents reported the frequency that their child demonstrated a range of activities that indicated that they were fully engaged with

the narrative during shared book reading (comment on the story, name pictures, guess the ending of the story and retell the story). These items, from the parental home literacy questionnaire, clearly loaded on a separate factor (child narrative engagement) from storybook exposure and parental teaching. The factor did significantly correlate with parental teaching ($r = .31$), but showed a non-significant correlation with storybook exposure. Surprisingly, however, child narrative engagement did not significantly correlate with any of the outcome measures. The reason for this may be that the items tapped into early higher-level comprehension skills, such as understanding story structure, rather than pre-reading skills. The children in the study were too young to have completed a reading comprehension task; however it may be useful to reassess the contribution of the child engagement factor at a later time when measures of the children's narrative and/or reading comprehension are available.

Consistent with previous studies (Hood et al., 2008; Sénéchal et al., 1996), the measurement of children's literacy interest was parental report of the frequency their child requested to be read to. Children's interest in reading significantly correlated with storybook exposure, but did not correlate with parental teaching or any of the pre-reading skills. Previous studies, using parent report, have reported mixed results. Sénéchal et al. (1996) found three to six year-old children's interest in book reading explained unique variance in receptive vocabulary; however, Hood et al. (2008) failed to find a relationship in their sample of five year olds. Other studies, directly measuring children's interest in literacy and literacy related measures in five year olds have found a unique contribution to letter knowledge (Fritjers et al., 2000) and emergent literacy (Martini & Sénéchal, 2012).

Although relationships between child interest and the early baseline measures of receptive vocabulary and letter knowledge were non-significant, it did account for unique variance in later word reading skills at the end of the children's reception year and, in combination with storybook exposure, it contributed to listening comprehension. As the children were aged five years at this time, the results lend support to Martini & Sénéchal's study (2012). The failure to find early relationships may be due to our limited measurement of child interest, which consisted of a single item with the majority of parents reporting that their children often requested being read to. However, it may have represented a behavioral trend that developed across the first year of schooling. It is a limitation of the study that we did not assess the children's literacy interest using child administered pictorial scales (Fritjers et al., 2000; Martini & Sénéchal, 2012). This direct measurement may have given more variability and retesting at the second time point would have allowed the investigation of the trajectory of children's literacy interest through the first year of formal literacy instruction.

3.4.4 Emergent literacy

Children were retested as they reached the end of their first year of full time education, when they were five years old. In contrast to previous studies with children of a similar age (Evans et al., 2000; Hood et al., 2008; Sénéchal, 2006; Sénéchal & LeFevre, 2002), the children in the current study had experienced a full year of formal literacy instruction. Also in contrast to the majority of home literacy studies, the children's home literacy environment was assessed at a younger age, when they were three to four years old, at the beginning of regular nursery (pre-

school). At the second time point, children's single word reading was assessed, as a measure of their emergent reading ability, and they completed a listening comprehension task as a measure of their linguistic comprehension. The aim was to investigate the direct and indirect pathways from home literacy practices (storybook exposure and parental teaching) and children's literacy interest to their word reading and comprehension skills, over and above the effects of age, non-verbal ability and the four pre-reading skills. In addition to the direct pathway from children's literacy interest to later single word reading ability, a further direct pathway was also found from parental teaching to later word reading ability. Results also showed an indirect pathway from parental teaching via baseline letter knowledge to later word reading. Baseline phonological awareness accounted for significant variance in later word reading. Storybook exposure was not associated directly or indirectly to later word reading skills; however, there was a direct pathway (in combination with children's interest in reading) to later listening comprehension and an indirect pathway from storybook exposure to later listening comprehension via preschool receptive vocabulary.

The findings are broadly consistent with the early pathways of the Home Literacy Model (Sénéchal & LeFevre, 2002) and later research (Hood et al., 2008; Martini & Sénéchal, 2012; Stephenson et al., 2008) that has found preschool parental literacy teaching predicts the word reading ability of five year olds. However, in these longitudinal studies, the researchers have gone on to measure children's literacy skills (word reading and comprehension) in later grades and consistently reported that the pathways from home literacy to later reading become indirect via emergent literacy skills after the start of formal education and literacy instruction.

The current findings provide evidence that this shift, from direct to indirect, may be related to age and other developmental factors rather than the influence of formal literacy instruction. This study found a direct pathway from pre-school parental teaching to word reading at age of five, even though the children had completed a year of formal literacy instruction.

Results relating to the contribution of exposure to storybooks at home to later language skills also support the early pathway of the Home Literacy Model.

Sénéchal & LeFevre (2002) reported a direct unique pathway from shared reading at home to language skills (a composite of receptive vocabulary and listening comprehension) at five years old. Measures in the current study differed in two ways. Firstly, a broader aspect of storybook exposure (including frequency of shared reading) was measured and secondly the two language skills were measured separately: baseline receptive vocabulary at the beginning of preschool and listening comprehension at the end of the reception year. The current results support and extend the model. Children's exposure to storybooks at three years uniquely contributed to their concurrent receptive vocabulary and, in combination with children's interest in reading, to listening comprehension at five years. In contrast to the model, which suggests that the influence of storybook reading at home becomes mediated by language skills after the start of formal education, the current results suggest that the direct pathway from the HLE remains, at least partially, significant after a year of formal education. Once again, these findings support the view that the switch from direct to indirect pathways may be related to maturational effects and not the commencement of formal literacy instruction.

3.4.5 Limitations

It should be noted that the children in the current study were from families where, in general, parents had achieved education levels above the norm. Additionally, parents were likely to have been interested in reading development to have completed and returned the home literacy questionnaire. The lack of diversity may have resulted in a more restricted range of scores than would have been found if the sample had extended to children from more disadvantaged backgrounds (Baroody & Diamond, 2012; Chow & McBride-Chang, 2003; Phillips & Lonigan, 2005). In addition, the use of parental self-report in this type of research poses its own challenges in obtaining valid data; potential social desirability effects may bias the responses of the parents. Using direct child-administered measures, wherever possible, is beneficial; however, finding suitable measures for these very young children is also challenging.

Much research in the field of home literacy has used parent report to assess the home literacy environment. However, there is a lack of consistency across studies regarding information requested from parents. Consequently, composite measures used in analysis may vary, leading to difficulty in comparison across studies (see Burgess, Hecht, & Lonigan, 2002; de Jong & Leseman, 2001). In the current research, parental teaching was measured as word based activities, but we failed to ask about teaching letter sounds and names. Parents were asked about teaching rhyming, but the single measure failed to clearly load on either the parental teaching or book exposure factors. It may have been useful to include further questions about teaching and playing games related to specific phonological skills to fully investigate their role in the development of emergent literacy skills.

Additionally, it would have been helpful to ask about literacy teaching opportunities during shared reading, for example reading ABC books, which have been found to provide more opportunities for drawing children's attention to print.

In this study, measures of child interest and engagement in home literacy practices were included. Findings were inconclusive, however, this area of research may be an important contribution to later studies of reading comprehension. Trajectories of home literacy practices change across the early years (Rodriguez & Tamis-LeMonda, 2011) and children's interest and engagement may also change as they begin formal literacy instruction. Further exploration of the socio-emotional quality of parent-child home literacy practices may add to the understanding of the dynamic nature of the pathways to children's emergent and developing literacy skills.

3.4.6 Conclusion and Implications

In conclusion, this study adds to growing evidence that there are two distinct types of home literacy practices: exposure to storybooks and parental literacy teaching. The findings extend previous research to show that, even with three-year-old children, exposure to storybooks contributed to the growth of their preschool receptive vocabulary and later emergent language skills at five years. Home parental teaching practices, with these very young children, contributed not only to their letter knowledge as they began preschool, but also to their later emergent

word reading skills. The results suggested that benefits from home literacy practices endured even following a year of formal literacy instruction at school.

For the development of emergent literacy, the findings of this study suggest that parental literacy teaching is equally as important as storybook exposure. The complexity of the relationship between all the pre-reading skills in non-readers suggest that growth in one skill will directly or indirectly foster growth in the other skills, therefore all aspects of home literacy experiences are beneficial to children's later reading skills. For example, storybook reading directly contributed to receptive vocabulary, which uniquely predicted preschool print knowledge, which in turn was associated with letter knowledge: the strongest predictor of emergent reading skills. Additionally, the findings suggest that children's interest in literacy also directly contributed to their later emergent word reading and listening comprehension skills. At three years old, children's interest was significantly related to storybook exposure, but not parental teaching, suggesting that shared book reading may also be important for its socio-emotional effects in promoting children's literacy interest.

Further research is needed to investigate the changing nature of home literacy practices as children progress through the early stages of formal education.

However, this study has extended current research to show that early, preschool home literacy practices promote growth in the pre-reading skills that are crucial to children's later reading development. Therefore, in addition to shared book reading, parents should be encouraged to explicitly teach letters, sounds and words to their children before they begin school, perhaps using shared book

reading as an opportunity to draw children's attention to the print. However, it is also vital to encourage children's literacy interest, therefore it is of equal importance to ensure that all aspects of home literacy practices remain enjoyable experiences for both parent and child.

Chapter 4 Cognitive precursors of reading comprehension

4.1 Introduction

Individual differences in decoding-related skills and oral language have been shown to predict individual differences in reading comprehension performance in school-aged children (Nation & Snowling, 2004; Sénéchal, Ouellette, & Rodney, 2006). Effective reading requires the coordination and interaction of these skills, and ultimately they become fully integrated in the fluent reader. Emergent literacy defines the period between pre-reading and reading, where the development of these cognitive skills becomes essential in the course of literacy development (Storch & Whitehurst, 2002). Evidence has suggested that the cognitive skills underpinning emergent literacy make their most significant contribution to reading performance at different points in development e.g., phonological awareness plays a critical role when children are beginning literacy instruction and learning to “crack” the code of written words, but its influence decreases in accomplished readers (Storch & Whitehurst, 2002; Whitehurst & Lonigan, 1998). A comprehensive review of the development of emergent literacy skills can be found in Chapter 1 (see 1.4). Although evidence is accumulating regarding the changing nature of relationships between cognitive factors during emergent literacy, less is known about children’s cognitive abilities at the beginning of preschool and their contribution to the acquisition of reading comprehension skills.

The Simple View of Reading (SVR; Gough & Tunmer, 1986; Hoover & Gough, 1990) aims to provide an overarching framework to understand reading comprehension

processes (see 1.2.1 for details). The SVR proposes that reading comprehension ability results from the product of word recognition skills and linguistic comprehension skills. Over the past decades word recognition skills have received considerable attention from researchers and links to later reading ability and reading comprehension have been well established (e.g., Nation & Snowling, 2004; Perfetti, Landi, & Oakhill, 2005). The contribution of linguistic comprehension skills remains less well defined and evidence from research examining these relationships has been contradictory regarding when they impact on emerging and developing literacy skills (Muter, Hulme, Snowling, & Stevenson, 2004; Storch & Whitehurst, 2002; Vellutino, Tunmer, Jaccard, & Chen, 2007). Some researchers have proposed that oral language skills are crucial to early reading comprehension (Paris & Paris, 2003) and others argue that these skills do not play a major role until adequate decoding skills have been developed (Vellutino et al., 2007).

Limitations of research may account for the conflicting results, as both oral language comprehension and reading comprehension have been conceptualized and measured in various ways across studies. The difficulty in assessing oral language skills compared to word reading skills is not surprising. Word recognition is a concrete construct that is easily measured, whereas language skills are multifaceted and more intangible. Similarly, inconsistencies have arisen through the use of different reading comprehension tasks. Tasks may involve passage or sentence reading; they may involve multiple choice questions or open questions, requiring oral or written answers, or they may involve the completion of sentences (referred to as a cloze task). Recent reviews have highlighted the implications of these inconsistencies and suggest that a range of different cognitive

abilities may be tapped, even within the commonly used assessments of reading comprehension (Bowyer-Crane & Snowling, 2005; Keenan, Betjemann, & Olson, 2008). In particular, research has shown that performance in passage reading comprehension tasks is predicted by word reading and listening comprehension; however, cloze tasks essentially measures only word recognition skills, as listening comprehension has not been found to uniquely predict performance in cloze tasks (Francis, Fletcher, Catts, & Tomblin, 2005; Nation & Snowling, 1997). As a result the contribution of and interaction between the various cognitive factors underpinning reading comprehension, particularly at acquisition, and the developmental trajectory of those skills, as reading comprehension skills improve, remains unclear.

Recent longitudinal studies have aimed to address the complex interaction between reading comprehension and its precursors (Kendeou, van den Broek, White, & Lynch, 2009b; Storch & Whitehurst, 2002; van den Broek, White, Kendeou & Carlson, 2009). These studies have examined the development of aspects of oral language and decoding skills in young children as they progress from early to mid to late primary school. Consistently, these studies have found that oral language and decoding skills do form distinct domains, as suggested by the SVR, in later primary school (Kendeou, Savage, & van den Broek, 2009a). However, the situation appears to be different in the very early school years. In pre-readers there is a stronger relationship between the two domains (oral language and decoding) and this relationship appears to consistently weaken in subsequent academic years until, by the second grade, both skill sets

independently predict reading comprehension (Kendeou et al., 2009b; Storch & Whitehurst, 2002).

Longitudinal studies have also reported that there is a strong level of continuity of both decoding and oral language skills over time, suggesting that early competencies contribute to later reading performance (Schatschneider, Fletcher, Francis, Carlson, & Foorman, 2004). To clarify the developmental trajectory it is vital to investigate the emerging skill sets in very young pre-readers and follow their progress to the acquisition of reading comprehension. Understanding the changing nature of the relationships between early cognitive factors and emergent reading comprehension will help to highlight the earliest markers for potential reading comprehension deficits.

In addition to oral language and decoding skills, other researchers have examined the role of executive function in early academic skills (Blair & Razza, 2007; Cartwright, 2012; McClelland et al., 2007). This work has produced evidence to suggest that working memory and attentional control play a key role in supporting emergent literacy and mathematical skills in primary school children. A recent longitudinal study extended this literature to examine these skills in four-year-old preschool children from low-income families (Welsh, Nix, Blair, Bierman, & Nelson, 2010). They found that both working memory and attentional control predicted growth in phonological awareness and print knowledge during the preschool year. Additionally, growth in preschool executive function skills uniquely contributed to variance in single word reading, non-word reading and story recall during the subsequent academic year. The results suggest that

executive function may support both dimensions of the SVR; however, Welsh et al. (2010) did not assess children's reading comprehension, so the direct relationship between preschool executive function and later reading comprehension remains unexplored. Further studies have explored the role of working memory once reading comprehension skills have become more established. Cain and colleagues found that working memory predicted concurrent reading comprehension in eight, nine and 11 year-old children over and above word reading ability, vocabulary and verbal ability (Cain, Oakhill, & Bryant, 2004a).

4.1.1 Aims of the current study

The overall aim of this study was to examine the early predictors of the two dimensions of the SVR in very young pre-readers and relate them to the acquisition of reading comprehension at the end of Year 1. This extends current knowledge in three ways. Firstly, it extends longitudinal developmental data to a younger sample of UK children. The children in this study completed baseline assessments when they were three to four years old (mean age = 3:10) and attending half-day nursery classes. Secondly, it includes an examination of the role of executive function in the developmental trajectory of reading comprehension acquisition in this young sample. Although executive function abilities have been investigated in young populations and some limited literacy outcomes have been included in such studies (e.g., Blair & Razza, 2007), to my knowledge there has not been a study incorporating these factors in relation to reading comprehension acquisition. Thirdly, the current study measured children's passage reading comprehension ability at an earlier time point. In most studies children are not

assessed in text passage reading comprehension before Year 2 and more often in the mid to late primary years. In this study, children completed the York Assessment of Reading Comprehension (YARC: Snowling et al., 2011) at the end of Year 1, when they were six years old. The YARC assesses the comprehension of text passage reading through a series of literal and inferential questions and is standardized from the age of five years.

4.1.2 Summary

The current study assessed young pre-readers (mean age = 3:10) during their first full term of half-day nursery. Baseline measures (Time 1) were established for non-verbal ability, letter knowledge, receptive vocabulary, language skills, phonological awareness, print knowledge and executive functions. Children's cognitive skills were reassessed one year later in Reception (Time 2) and once again, a further sixteen months later, at the end of Year 1 (Time 4). Outcome measures of language comprehension and word reading, representing the two dimensions of the SVR, were also assessed at the end of the Reception Year (Time 3) and at the end of Year 1 (Time 4). A standardized assessment of reading comprehension was also conducted at the end of Year 1 (Time 4).

The primary aim of the study was to investigate the early precursors of the two domains of the SVR and examine their predictive relationship to reading comprehension at the end of Year 1. Further, it aimed to examine the degree to which factors underpinning the two SVR domains were inter-related at each time point. Based on a two-domain conceptualization of literacy development (Storch &

Whitehurst, 2002), it was expected that the cluster of oral language skills and the cluster of decoding skills would be more strongly connected to each other at the first two time points when the children were three to five years old (Time 1 and Time 2), and less strongly connected by the end of Year 1 (Time 4). Additionally, as proposed by the SVR, it was expected that both word reading ability and language comprehension would independently predict reading comprehension at the end of Year 1, and, within this young age group, word reading ability would account for a greater proportion of variance.

The secondary aim of the study was to investigate the role of executive function in the developmental trajectory of reading comprehension acquisition. Measures of working memory and cognitive inhibition were taken at each time point, and concurrent and longitudinal relationships with the two domains of the SVR were examined. Previous research has reported an association between executive function and both word reading and oral language skills; therefore it was hypothesized that these skills, particularly working memory capacity, would significantly contribute to both dimensions of the SVR.

4.2 Method

4.2.1 Participants

At Time 1 (T1), the initial sample comprised of 98 preschool children (51 boys and 47 girls; mean age = 3:10 years, *SD* = 3.5 months) attending the nursery year of two mainstream primary schools in South East England (refer to 2.4 for details). At Time 2, in the reception year, 84 children (43 boys and 41 girls; mean age = 4:10 years, *SD* = 3.8 months) were available for retesting. At T3, at the end of the

reception year, 83 children (42 boys and 41 girls: mean age = 5:02 years, $SD = 3.8$ months) were reassessed. Finally, at Time 4 (T4), the end of Year 1, 80 children (41 boys and 39 girls) were available for retesting (mean age = 6:03 years, $SD = 3.8$ months). The current study includes data from the 80 children with complete data sets.

4.2.2 Materials & Measures

Brief descriptions of materials and measures for each time point are given below. For further, more comprehensive details of the materials and scripts for administration refer to Chapter 2.

4.2.2.1 Time 1 (T1): Nursery (spring term)

4.2.2.1.1 Nonverbal ability

The Block Design subtest of The Wechsler Preschool and Primary Scale of Intelligence – III (WPPSI-III) (Wechsler, 2002) was used to measure children's non-verbal ability. The maximum score was 19.

4.2.2.1.2 Letter knowledge

The Alphabet Knowledge subtest of the PAT (Muter, Hulme, & Snowling, 1997) was used to establish children's alphabet knowledge. Children were presented with each letter of the alphabet printed individually on a card, and asked to give the name and/or sound of that letter. The maximum score was 26.

4.2.2.1.3 Print knowledge

The Print Knowledge subtest of the Test of Preschool Early Literacy (TOPEL) (Lonigan, Wagner, Torgeson, & Rashotte, 2007) was used to measure children's print knowledge. The Print Knowledge subtest (12 items) measures early knowledge about written language conventions and form. Maximum score was 12.

4.2.2.1.4 Phonological awareness

To assess children's phonological awareness (PA), two subtests of the Phonological Abilities Test (PAT; Muter et al., 1997) were used: rhyme detection (maximum score = 10) and word completion (maximum score = 16).

4.2.2.1.5 Oral language skills

Children's receptive vocabulary was assessed using the British Picture Vocabulary Scale: 2nd Edition (Dunn, Dunn, Whetton, & Burley, 1997). The maximum score was 84. Receptive and expressive language abilities were measured through two subtests (linguistic concepts and recalling sentences in context) of the Clinical Evaluation of Language Fundamentals – Preschool Second Edition (CELF-Preschool-2; Wiig, Secord, & Semel, 2004). Maximum score was 20 for linguistic concepts and 52 for recalling sentences.

4.2.2.1.6 Executive function

4.2.2.1.6.1 *Working memory*

Two tasks were used to assess children's working memory ability: one word based and one digit based. The Reverse Word Span task (Slade & Ruffman, 2005)

required children to reverse sets of two and three words orally presented by the researcher. An age-appropriate digit task was developed to further assess the children's working memory. The Cat and Mouse Working Memory Task (based on previous research by Keenan, 1998) consisted of a series of counting cards each showing coloured illustrations of a number of cats and twice the number of mice (ranging from 1 cat/2 mice to 6 cats/12 mice). Children were required to count, retain and then recall numbers from a series of two or three cards. Maximum score was 9 for the Reverse Word Span task and 30 for the Cat and Mouse task.

4.2.2.1.6.2 Cognitive inhibition

The Day-Night inhibition task (Carlson & Moses, 2001) was used to assess children's cognitive inhibition. The task required children to inhibit a verbal response to a visual stimulus. Children were shown pictures of a sun, to represent day, and a moon to represent night. To provoke an inhibitory response, the child was then required to respond 'night' when shown the picture of the sun, and to respond 'day' when shown the picture of the moon. Maximum score was 16.

4.2.2.1.6.3 Cognitive flexibility

A card-sorting task, adapted from Kloo and Perner's (2003) Dimensional Card Sorting task, was used to assess children's cognitive flexibility. This task required children to switch responses following a change of game rules. Initially, children were asked to sort a set of 9 cards (3 x yellow horse, 3 x red fish and 3 x blue bird) based on the colour of the illustrations. The test phase required the child to shift from their colour-based response to an animal-based response, as they were asked

to sort another identical set of cards based on the type of animal illustrated on the card. Maximum score was 9.

4.2.2.2 Time 2 (T2): Reception (spring term)

4.2.2.2.1 Decoding

The Alphabet Knowledge subtest of the PAT (Muter et al., 1997) was re-administered to measure children's alphabet knowledge. Maximum score was 26.

The single word-reading subtest of the British Ability Scales (Elliott, Murray & Pearson, 1983) was used to establish children's single word reading. Maximum score was 30.

4.2.2.2.2 Print knowledge

The Print Knowledge subtest of the Test of Preschool Early Literacy (TOPEL) (Lonigan et al., 2007) was re-administered.

4.2.2.2.3 Phonological awareness

The syllable and phoneme completion subtests of the Phonological Abilities Test (PAT; Muter et al., 1997) were re-administered.

4.2.2.2.4 Oral language skills

The Definitional Vocabulary Subtest of the Test of Preschool Early Literacy Skills (TOPEL; Lonigan et al., 2007) was used to gain a measure of the breadth and depth of the children's vocabulary knowledge. There were 35 items, with a potential

score of 2 for each item (one for naming the item and one for a related question) giving a maximum score of 70.

Narrative recall was assessed using the Renfrew Bus Story Test 4th edition (Renfrew & Hancox, 1997). Children listened to a story, told by the researchers, with accompanying illustrations. Immediately following the narrative, children were asked to retell the story using the same illustrations. Children's narrative recall was recorded, transcribed and scored using the information subtest of the Bus Story Test (see Appendix 6 for example). The scores reflected two aspects of the child's recall of the story: knowledge of content and order of narrative. Maximum score was 52.

4.2.2.2.5 Executive function

4.2.2.2.5.1 *Working memory*

The reverse word span task (Slade & Ruffman, 2005) was re-administered to assess children's working memory.

4.2.2.2.5.2 *Cognitive inhibition*

Two tasks were used to assess the children's inhibitory control. *Luria's hand game* (Hughes, 1998; Luria, Pribam, & Homshaya, 1964) was a test of inhibition. The child initially imitated the researcher's hand movements (make a fist or point a finger). Subsequently, the rules changed for the test trials and the child was required to make the opposite movement from the researcher. Maximum score was 15. "*Wack-A-Mole*" (Stimuli courtesy of Sarah Getz and the Sackler Institute

for Developmental Psychobiology) was a computerized task using a go/ no go paradigm. Children 'played' the game over four two minute trials. During each trial, they were required press the spacebar when they saw a mole appear from a hole in the garden, but refrain from reacting if a vegetable appeared. The score for the task was the mean accuracy of the 'No Go' trials.

4.2.2.3 Time 3 (T3): Reception (end of year)

4.2.2.3.1 Single word reading

The Early Word Recognition subtest of the York Assessment of Reading for Comprehension (YARC; Snowling et al., 2009) was used to assess emergent word reading skills. The test consists of 30 words; all familiar to young children, but found in varying frequency in children's literature. The test consists of 15 regular words (e.g., frog), which can be phonologically decoded according to Grapheme Phoneme Correspondence rules to produce the correct pronunciation, and 15 irregular words (e.g., bird), which cannot be read correctly using phonologically decoding. In this study, the total number of words read by the child was recorded, giving a maximum score of 30.

4.2.2.3.2 Listening comprehension

Stories taken from the Neale Analysis of Reading Ability (NARA; Neale, 1997) were used to assess children's listening comprehension. For each story an accompanying black and white illustration was placed in front of the child and the researcher read the story. The child did not see the text. Following each story, the researcher asked comprehension questions. The stories were presented in

sequence, as they increase in length and difficulty, until the child failed to correctly answer any of the comprehension questions. Maximum score was 24.

4.2.2.4 Time 4 (End Year 1)

4.2.2.4.1 Reading comprehension

The York Assessment of Reading for Comprehension: Passage Reading (YARC; Snowling et al., 2011) was used to assess children's comprehension skills. The standardised test comprised of graded passages, alternating between fiction and non-fiction, for reading aloud by children aged five to 11 years. Children were required to read two passages. Following each passage, children were asked a set of eight comprehension questions tapping literal and inferential comprehension skills.

In preparation for the YARC, children completed the Single Word Reading Test (SWRT; Foster, 2007). This test consisted of six graded sets of ten words of increasing difficulty. Maximum score was 60. The raw score from the SWRT determined the starting passage level for the YARC. Children then completed two consecutive passages from the YARC. Children were timed as they read the passages aloud, with the exception of the beginner's passage. The accuracy of their reading was recorded for all passages. Standard scores were calculated for comprehension skills, accuracy of reading and, when possible, reading rate; however only the comprehension score is used in the analyses in this study. In light of the SVR, reading efficiency was measured as word, rather than passage reading, and an alternative test was used (see below).

4.2.2.4.2 Reading efficiency

The Test of Word Reading Efficiency (TOWRE; Rashotte, Torgesen, & Wagner, 1999) was used to measure children's word reading accuracy and fluency. The TOWRE is standardised from six years old and consists of two subtests to provide measures of sight word reading efficiency and decoding efficiency. Data from the subtests are combined to provide an overall reading efficiency score.

4.2.2.4.3 Phonological awareness

Two subtests of the Comprehensive Test of Phonological Processing (CTOPP; Wagner, Torgesen, & Rashotte, 1999) were used to assess children's phonological processing: elision and blending words. Maximum score was 20 for each of the subtests.

4.2.2.4.4 Oral language skills

The British Picture Vocabulary Scale: 2nd Edition (Dunn et al., 1997) was re-administered to assess the children's receptive vocabulary. Children's narrative recall and comprehension ability was assessed using a task based on the work of Paris and Paris (2003). A shorter form of a wordless picture book ("Robot-Bot-Bot" by Fernando Krahn) was given to the child to 'read'. Children were asked to use the book to tell the story to the researcher. Once the book was completed, and removed, children were asked to recall the story. Children's recall was recorded and transcribed. Scoring considered six aspects of the narrative (characters, setting, initiating event, problem, solution, and ending) and one point was awarded

for each. Additionally, up to three further points were awarded for awareness of story structure, giving an overall maximum score of 9.

Following the recall, the book was replaced in front of the child and the researcher asked the child a set of ten comprehension questions, turning to the corresponding page of the book before asking each question. Children's responses were transcribed in full and marked using a scoring rubric that awarded 0 points for an incorrect answer, one point for a partially correct answer and two points for a full answer giving a maximum score of 20 points. An overall narrative comprehension score was calculated by summing the recall and comprehension scores to give a maximum total of 29.

4.2.2.4.5 Executive function

4.2.2.4.5.1 *Working memory*

Children completed two working memory tasks to assess the processing and storage of digits and words (Cain et al., 2004a). The digit working memory task required children to read aloud groups of three digits and remember the last digit from each group in the same order as presentation for later recall. The sentence-span task involved children listening to groups of short sentences with the final word missing. Children were required to finish the sentence and remember their words for later recall, once again in the same order as presentation. One point was awarded for every correct digit/word that was recalled in its correct location, giving a maximum score of 27 for each task.

4.2.2.4.5.2 Cognitive inhibition

A task using the Stroop paradigm (based on a previous study by Prevor & Diamond, 2005) was developed to assess cognitive inhibition: the colour/object switch task. The task consisted of three timed tests. The first required children to name colours on a page of 20 coloured line drawings of squares (4 x 5 colours). The second required them to name 20 line drawings of objects (4 x 5 object types) shown in their congruent colours, e.g., pink pig, blue whale. In the third test, children were shown another 20 line drawings of the same objects, but this time the drawings used incongruent colours, and children were asked to name the colours. Before each test, the child was told that the aim was to name the items as fast as possible. The interference score (measured in seconds) was calculated by subtracting the predicted score (mean time of test 1 and test 2) from the time of test 3.

4.2.3 Procedure

Informed (opt-in) consent was obtained from the head teachers of the schools. Detailed information about the longitudinal study was sent home to parents, including a 'opt out' consent form (see 2.3 for details).

4.2.3.1 Time 1 (T1)

Children were initially tested during the second term in their nursery year. Children were tested individually in a quiet area immediately outside of their classroom. The tasks formed part of a larger battery of baseline assessments, and each child completed four 15 to 20 minute sessions administered by one of four

researchers (mean assessment period = 21.32 days, SD = 7.17). Administration of the test sessions was fully counterbalanced both within the session itself and in the order with which the children completed the sessions. (See 2.5.2 for further details.)

4.2.3.2 Time 2 (T2)

Children were reassessed, one year later, at the beginning of the second term of the reception year (T2). Once again, children were tested individually in a quiet area close to their classrooms. Each child completed two 20-minute assessment sessions (mean period between assessment sessions = 6 days, SD = 4.25). Test sessions were counterbalanced, as were the tasks within the sessions. (See 2.5.3 for further details.)

4.2.3.3 Time 3 (T3)

Children were retested, four months later, at the end of the reception year. At this time, children completed a single test session of 20 minutes, in a quiet area outside of their classroom. Tasks within the session were counterbalanced. (See 2.5.4 for further details.)

4.2.3.4 Time 4 (T4)

In Year 1, children were tested at the end of the summer term. As before, children were tested individually in a quiet area outside of their classrooms. At Time 4, children completed three 20-minute sessions (mean assessment period = 11 days, SD = 7.09). (See 2.5.5 for further details.)

4.3 Results

4.3.1 Descriptive statistics

Descriptive statistics for all variables across the four time points are shown in Table 4.1. Distributions for most variables were acceptable, however a significant positive skew was observed in T1 letter knowledge, suggesting floor effects.

Further investigation revealed that 43.9% of the children knew no more than 2 letters sounds, reflecting the fact that these young children had not begun formal education. Conversely, the distribution of measures of cognitive inhibition showed negative skew, suggesting ceiling effects. Indeed, for the Day/ Night task at T1, 65% of the children successfully passed 75% of the conflict trials. At T2, 56.3% of the sample scored the maximum scores for Luria's hand game. At T4, the distribution of the Colour-Object-Switch task had a positive skew, suggesting that the majority of the sample showed low interference scores (where high scores indicated high levels of cognitive interference between conditions).

Square root transformations were performed to address variables with a positive skew and a reflection and square root transformation was applied to those variables with a negative skew. Data resulting from the Colour-Object-Switch task was also reflected for ease of interpretation, such that a higher score indicated better performance on the task. The transformed variables were used in the analyses.

Table 4.1: Means and standard deviations for cognitive variables at T1, T2, T3 and T4

	Max	N	Mean	SD	Range
T1 Nursery – spring term					
Non verbal ability					
Block design (Scaled score)	19	80	12.09	3.05	4-18
Decoding					
Letter knowledge (PAT)	26	80	7.15	7.44	0-25
Print knowledge					
TOPEL print knowledge	12	80	5.74	2.69	1-12
Phonological awareness					
PAT Rhyme	10	80	5.04	3.12	0-10
PAT word completion	16	80	5.73	3.93	0-15
Language					
Receptive vocabulary (BPVS)	84	80	47.19	10.27	23-71
CELF recall sentence	52	80	34.12	10.08	2-52
CELF linguistic concepts	20	80	14.29	4.00	1-20
Executive function					
Reverse word span WM task	9	80	2.19	2.53	0-8
Cat & mouse WM task	30	78	5.99	5.41	0-20
Day/night task	16	80	11.63	4.50	0-16
Card sorting	9	80	5.43	3.59	0-9
T2 Reception – spring term					
Decoding					
Word reading (BAS)	30	80	4.86	4.91	0-23
Letter knowledge (PAT)	26	80	19.30	6.53	18-32
Print knowledge					
TOPEL print knowledge	12	80	8.95	2.46	4-12
Phonological awareness					
PAT Rhyme	10	80	6.79	3.08	0-10
PAT word completion	16	80	10.37	4.35	1-16
Oral Language					
Definitional Vocabulary (TOPEL)	70	80	55.24	6.16	43-67
Narrative comprehension (Bus story)	52	80	19.05	7.38	5-35
Executive function					
Reverse word span WM task	15	80	4.69	2.60	0-10
Luria's hand game	15	80	14.00	1.57	7-15
Wack-a-mole (seconds)	-	80	0.78	0.14	.31-1.00
T3 Reception – end of year					
Decoding					
Single word reading (YARC)	30	80	13.66	7.77	0-30
Oral language					
Listening comprehension (NARA)	24	80	10.16	4.67	1-20
T4 Year 1 – end of year					
Decoding					
Reading Efficiency (TOWRE) (SS)		80	123.56	15.86	90-154
Phonological awareness					
CTOPP Blending	20	80	12.03	3.28	4-19
CTOPP Elision	20	80	10.11	4.80	1-20
Oral Language					
Receptive Vocabulary (BPVS)	120	80	74.71	11.64	45-102
Narrative comprehension	29	80	18.01	4.52	9-27
Executive function					
Sentence span WM task	27	80	9.99	3.16	0-15
WM digit task	27	80	8.16	3.11	1-15
Colour Object Switch (secs)	-	79	9.43	6.47	-.61-29.68
Reading comprehension					
YARC (SS)	-	80	108.03	9.17	81-125

Note: T1 = Time 1; T2 = Time 2; T3 = Time 3; T4 = Time 4; All raw scores unless otherwise noted; SS = standard scores; PAT = Phonological Abilities Test; TOPEL = Test of Preschool Early Literacy; BPVS = British Picture Vocabulary Scale; CELF = Clinical Evaluation of Language Fundamentals; WM = working memory; BAS = British Ability Scales; YARC = York Assessment of Reading for Comprehension; NARA = Neale Assessment of Reading Ability; TOWRE = Test of Word Reading Efficiency; CTOPP = Comprehensive Test of Phonological Processes

4.3.2 Data Reduction

In order to reduce the number of predictor variables, composite scores were calculated for constructs assessed through multiple tasks. Composite scores were used in all analyses, with the exception of language measures. In correlation analyses, separate language measures were reported in addition to composite values to determine whether the influence of vocabulary on reading comprehension differed from other language and narrative skills.

4.3.2.1 *Early reading skills.*

T2 scores from the PAT letter knowledge subtest and from the BAS single word reading subtest were significantly correlated ($r = .67, p < .001$). The scores from each task were standardized and summed to give a composite score providing an overall measure of emergent decoding skills. At T4, the TOWRE was used to measure early reading skills as it incorporated both speed and accuracy of reading single words and non-words. The TOWRE is standardized from six years old; therefore standardized composite scores were used².

² There was some concern about reliability of the task for very young children; however, preliminary analysis showed TOWRE scores were normally distributed and, highly correlated with concurrent scores on the Single Word Reading Test (SWRT 6-16; Foster, 2007), and YARC (Snowling et al., 2009) passage reading accuracy and reading rate ($r = .86, .83, .89$ respectively) suggesting that the data provided a reliable measure of reading ability for this sample.

4.3.2.2 Phonological awareness

At T1 and T2, phonological awareness (PA) was measured using two subtests from the PAT (rhyme detection and word completion). At both time points the two tasks were significantly correlated (T1, $r = .34, p < .01$; T2, $r = .54, p < .001$) and composite scores were calculated by summing the two scores at each time. At T4, PA was assessed using two subtests from the CTOPP (elision and blending). These scores also significantly correlated ($r = .46, p < .001$) and once again the composite score was calculated by summing the two scores.

4.3.2.3 Language skills

Composite scores were calculated for language ability at each time point with the aim of developing a richer measure of language comprehension than would be provided by a measure of vocabulary alone, in line with the linguistic dimension of the SVR. At T1, two subtests of the CELF (recalling sentences and linguistic concepts; $r = .51, p < .001$) were summed to form a language skills score. This measure significantly correlated with BPVS receptive vocabulary ($r = .66, p < .001$). Therefore, standard scores for CELF and BPVS scores were calculated and summed for an overall T1 language composite score. At T2, TOPEL descriptive vocabulary and the Bus Story narrative retell task were significantly correlated ($r = .52, p < .001$). Both measures were standardized and summed to give an overall T2 language comprehension composite score. At T4, BPVS receptive vocabulary and the Robot narrative retell and comprehension task significantly correlated ($r = .38, p < .01$). Once again, both measures were standardized and summed to form

a composite score. At T3, language ability was assessed with a single listening comprehension task.

4.3.2.4 Working memory³

At T1 and T4, working memory was measured through one word-related task and one digit-related task. At T1, the reverse word span task and the Cat & Mouse task were significantly correlated ($T1, r = .36, p < .01$). At T4, the sentence span task and the digit working memory task were also significantly correlated ($r = .33, p < .01$). At both times, the scores for the two tasks were standardized and summed to give a working memory composite score for each time point. At T2, working memory was assessed using only a word-related task.

4.3.3 Correlation Analyses

Zero-order correlations were conducted to examine concurrent and longitudinal relationships between measures at all time points. In order to further examine the relationships between different types of language skills and later reading comprehension, both individual and composite language measures were included in the correlational analysis. Results are reported in Table 4.2. Initial evaluation of the results indicated that the majority of key variables significantly correlated with each other, both concurrently and longitudinally.

³ Measures of cognitive inhibition were not significantly inter-correlated; therefore composite scores for inhibition or overall executive function ability were not calculated at this time.

Additionally, none of the cognitive inhibition measures were found to significantly correlate with T4 reading comprehension; therefore these measures were excluded from the analyses.

Table 4.2: Zero-order correlations between cognitive variables at T1, T2, T3 and T4

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Nursery																								
T1																								
1. Age	-																							
2. NVA	.02	-																						
3. LK	.09	.33**	-																					
4. PK	.02	.26**	.54**	-																				
5. PA	.31**	.36**	.61**	.43**	-																			
6. Vocabulary	.47**	.35**	.31**	.40**	.47**	-																		
7. Lang. skills	.40**	.33**	.45**	.50**	.52**	.67**	-																	
8. Lang. comp.	.48**	.37**	.43**	.49**	.54**	.91**	.91**	-																
9. WM	.52**	.32**	.41**	.27*	.57**	.47**	.55**	.56**	-															
Reception																								
T2																								
10. Decode	.18	.35**	.72**	.49**	.52**	.37**	.52**	.48**	.48**	-														
11. PK	.32**	.29**	.44**	.42**	.45**	.42**	.45**	.44**	.39**	.50**	-													
12. PA	.26*	.42**	.54**	.46**	.65**	.47**	.65**	.55**	.46**	.64**	.54**	-												
13. Vocabulary	.47**	.26*	.41**	.36**	.45**	.64**	.45**	.70**	.48**	.48**	.57**	.49**	-											
14. Narrative	.30**	.32**	.29**	.28*	.40**	.57**	.55**	.61**	.55**	.34**	.24*	.44**	.52**	-										
15. Lang. comp.	.44**	.32**	.45**	.36**	.49**	.70**	.68**	.76**	.59**	.47**	.47**	.54**	.87**	.87**	-									
16. WM	.33**	.25*	.44**	.39**	.55**	.44**	.45**	.49**	.48**	.53**	.39**	.62**	.49**	.44**	.54**	-								
Reception																								
T3																								
17. Word read	.15	.42**	.67**	.40**	.59**	.29**	.49**	.43**	.47**	.77**	.50**	.59**	.45**	.34**	.46**	.55**	-							
18. List Comp.	.24*	.16	.32**	.37**	.47**	.49**	.51**	.54**	.46**	.29**	.35**	.40**	.61**	.65**	.72**	.32**	.26*	-						
Year 1																								
T4																								
19. Read	-.13	.38**	.55**	.31**	.31**	.08	.25*	.18	.22	.54**	.37**	.43**	.24*	.19	.26*	.41**	.69**	.09	-					
20. PA	.05	.24*	.38**	.23*	.36**	.15	.40**	.30**	.34**	.46**	.28*	.49**	.25*	.20	.26*	.42**	.66**	.11	.57**	-				
21. Vocabulary	.31**	.37**	.35**	.43**	.44**	.68**	.68**	.72**	.40**	.41**	.41**	.56**	.67**	.66**	.76**	.41**	.36**	.66**	.24*	.21	-			
22. Narrative	.41**	.18	.18	.27*	.23*	.43**	.43**	.46**	.44**	.25*	.30**	.30**	.38**	.35**	.43**	.19	.24*	.39**	.07	.12	.38**	-		
23. Lang. comp.	.43**	.33**	.34**	.42**	.40**	.67**	.63**	.71**	.50**	.40**	.43**	.51**	.63**	.61**	.72**	.37**	.36**	.63**	.18	.20	.83**	.83**	-	
24. WM	.26*	.40**	.46**	.20	.42**	.31**	.39**	.39**	.54**	.49**	.26*	.41**	.38**	.25**	.36**	.46**	.60**	.18	.40**	.49**	.27*	.28*	.33**	-
25. Read comp.	-.09	.36**	.49**	.26*	.38**	.26*	.41**	.36**	.37**	.51**	.26*	.40**	.33**	.40**	.42**	.30**	.47**	.42**	.54**	.36**	.47**	.30**	.43**	.35**

Notes: $N = 80$; * $p < .05$; ** $p < .01$; NVA = non-verbal ability; LK = letter knowledge; PK = print knowledge; PA = phonological awareness; WM = working memory; T1 = Time 1; T2 = Time 2; T3 = Time 3; T4 = Time 4

The primary aim of this study was to determine the predictive relationships between early cognitive measures and later, emergent reading comprehension, within the framework of the SVR. Relationships between concurrent T1 measures are first reported to establish baseline associations between the variables. Subsequently, analysis focuses on the longitudinal relationships between early T1 cognitive variables and measures of decoding/word reading skills and linguistic comprehension at T2 and T3, to investigate whether T1 variables significantly related to one or both dimensions of the SVR. Finally, the relationships between T1 cognitive factors and T4 variables, including word reading efficiency, linguistic comprehension and reading comprehension, are reported. A further aim of the study was to determine the longitudinal stability of constructs and the relationship between the decoding/word reading dimension and the language dimension at each time point. Therefore, longitudinal relationships within constructs are also reported and the relationships between the SVR dimensions are examined to determine if they form distinct skill sets at each time point.

4.3.3.1 Nursery (T1): concurrent and longitudinal relationships

4.3.3.1.1 Concurrent relationships between Nursery (T1) variables

At T1, non-verbal ability significantly correlated with all measures. In contrast, age significantly correlated with language measures, PA and working memory, but not with letter or print knowledge. The code-related skills (letter knowledge, print knowledge and PA) were significantly inter-correlated; however the strongest relationship was between letter knowledge and PA ($r = .61, p < .01$). Both language measures (BPVS vocabulary and CELF language skills) significantly correlated with

code-related measures, suggesting that cognitive factors underpinning the two SVR domains are not independent skill sets in these very young children. Working memory significantly correlated with all measures.

4.3.3.1.2 T1 and T2 (decoding and language skills)

T1 letter knowledge was the strongest correlate of T2 decoding skills ($r = .72, p < .001$), although there were also significant correlations between T2 decoding and T1 print knowledge, PA and language skills ($r_s = .49, .52, .45$, respectively, all $p_s < .01$ respectively). T1 letter knowledge was also significantly correlated with T2 language comprehension (TOPEL definitional vocabulary and Bus narrative retell). When examining the T2 language measures independently, significant correlations were seen between T1 letter knowledge and T2 definitional vocabulary ($r = .41, p < .01$) and between T1 letter knowledge and T2 narrative skills ($r = .29, p < .01$). Strong, significant correlations were found between all T1 and T2 language measures ($r_s = .45$ to $.76$, all $p_s < .001$). T1 language (BPVS vocabulary and CELF language skills) also significantly correlated with T2 print knowledge and T2 PA ($r_s = .44, .55$, all $p_s < .001$ respectively). T1 working memory significantly correlated with all T2 variables.

4.3.3.1.3 T1 and T3 (single word reading and listening comprehension)

In line with the SVR domains, single word reading and listening comprehension were measured at T3. T1 letter knowledge and PA both strongly correlated with T3 single word reading ($r_s = .67, .59$, all $p_s < .001$). Additionally, T1 print knowledge significantly related to T3 single word reading ($r = .49, p < .001$). Both

T1 language measures also significantly correlated with T3 single word reading, although language skill ($r = .48, p < .01$) was a stronger correlate than receptive vocabulary ($r = .29, p < .01$). As expected, strong correlations were found between both T1 language measures and T3 listening comprehension ($r_s = .49, .51$, all $p_s < .001$). Additionally, T1 letter knowledge, print knowledge and PA were significantly related to listening comprehension ($r_s = .32, .37, .47$, all $p_s < .01$ respectively). T1 working memory was significantly related to both single word reading ($r = .47, p < .01$) and listening comprehension ($r = .46, p < .01$), once again suggesting that working memory is important for both SVR domains.

4.3.3.1.4 T1 and T4 (reading comprehension and SVR domains)

At T4, reading comprehension was assessed using the YARC. In addition, SVR domains were measured as reading efficiency (TOWRE) and language comprehension (BPVS receptive vocabulary and Robot narrative retell and comprehension). Results showed that all T1 variables significantly correlated with T4 reading comprehension. T1 letter knowledge was the strongest correlate ($r = .49, p < .001$). When considered separately, both T1 language measures were significantly correlated with T4 reading comprehension (T1 vocabulary, $r = .26, p < .05$; T1 language skills $r = .41, p < .01$). When considering the word reading dimension of the SVR, T1 letter knowledge was the strongest correlate of T4 reading efficiency ($r = .55, p < .001$). Both T1 PA and print knowledge were also significantly correlated with T4 reading efficiency ($r_s = .31, .31$, all $p_s < .01$). In contrast to previous time points where vocabulary significantly correlated with measures of early reading, T1 receptive vocabulary did not significantly correlate

with T4 reading efficiency ($r = .08$, *ns*). However, T1 language skill was a weak, but significant correlate of T4 reading efficiency ($r = .26$, $p < .05$).

Both T1 language measures were significantly and strongly correlated with T4 language comprehension (T1 vocabulary, $r = .67$, $p < .001$; T1 language skills $r = .63$, $p < .001$). Additionally, T4 language comprehension was moderately correlated with T1 code-related skills (T1 letter knowledge, $r = .34$, $p < .01$; T1 print knowledge, $r = .42$, $p < .01$; T1 PA, $r = .40$, $p < .01$). However, when the T4 language measures were considered separately, T4 vocabulary was moderately and significantly related to all three T1 code-related measures ($r_s = .35, .43, .44$, all $p_s < .01$), but narrative comprehension was only weakly correlated with T1 print knowledge ($r = .27$, $p < .05$) and phonological awareness ($r = .23$, $p < .05$) and was not significantly correlated T1 letter knowledge ($r = .18$, *ns*). T1 working memory was significantly correlated with T4 reading comprehension ($r = .37$, $p < .01$) and T4 language measures ($r = .50$, $p < .001$), but it was not significantly related to T4 reading efficiency ($r = .22$, *ns*).

4.3.3.2 Stability of measures

Age-appropriate tasks were employed across the four time points to avoid floor and ceiling effects, resulting in a range of measures used to assess constructs at different time points. Zero-order correlations (Table 4.2) between time points for each construct are discussed below. For ease of interpretation, correlations between time points for decoding and language skills are shown in table format (Tables 4.3 and 4.4 respectively).

4.3.3.2.1 Decoding/ word reading

Zero order correlations between decoding skills at each of the four time points are shown in Table 4.3. Strong correlations were found between all the measures indicating that individual differences in decoding ability remained stable across the study.

Table 4.3:

Zero-order correlations between decoding measures at T1, T2, T3 and T4

	T1	T2	T3
T1 Letter knowledge	-		
T2 Decoding	.72***	-	
T3 Single word read	.67***	.77***	-
T4 Reading efficiency	.55***	.54***	.69***

Notes: *** $p < .001$; T1 = Time 1; T2 = Time 2; T3 = Time 3; T4 = Time 4

Phonological awareness was measured at T1, T2 and T4. The same tasks were used at T1 and T2, Strong and significant correlation was found between scores at the two time points ($r = .65, p < .001$). The magnitude of the relationships between T4 PA and earlier measures of PA were moderate (T1 and T4, $r = .36, p < .01$; T2 and T4, $r = .49, p < .001$). Print knowledge was measured at T1 and T2, using the same task. Scores at the two time points were significantly correlated ($r = .42, p < .001$).

4.3.3.2.2 Language

Language skills were assessed with a range of different measures at each time point; however at T1, T2 and T4 each composite included a vocabulary measure. The exception was T3, when only listening comprehension was assessed. Zero order correlations for language composite measures and listening comprehension

are reported in Table 4.4. Strong correlations were found between the measures at each time point, suggesting stability of individual differences in language ability and reliability of tasks across the four time points.

Table 4.4:
Zero-order correlations between language composite measures at T1, T2, T3 and T4

	T1	T2	T3
T1 Language skills	-		
T2 Language comprehension	.76***	-	
T3 Listening comprehension	.54***	.72***	-
T4 Language comprehension	.71***	.72***	.63***

Notes: *** $p < .001$; T1 = Time 1; T2 = Time 2; T3 = Time 3; T4 = Time 4

4.3.3.2.3 Working memory

Working memory was assessed at T1 and T4 using both word- and digit-related tasks. At T2, only the T1 word-related task was re-administered. Correlation coefficients across the time points were moderately large ($r_s = .46$ to $.54$, all $p_s < .001$), suggesting that the tasks were reliable and relative stability in individual differences was demonstrated across the study.

4.3.3.3 Concurrent relationships between SVR Dimensions

Performance on measures of decoding and language skills appeared to be relatively stable across the time points. The SVR proposes that these two skill sets are distinct; however recent research has suggested that the dimensions are more closely related in the early years. Zero order correlations between the dimensions at each time point support this recent view. At T1, letter knowledge and the language composite (BPVS receptive vocabulary and CELF language skills) were significantly correlated, ($r = .43$, $p < .001$). Similarly, at T2, decoding (letter

knowledge and single word reading) and the language composite (TOPEL definitional vocabulary and Bus narrative retell) were significantly related, ($r = .47, p < .001$). However, the relationship between the two domains at T3 (single word reading and listening comprehension), although still significant, appeared weaker, $r = .26, p < .05$. Finally, at T4, the two dimensions, measured by word reading efficiency and language comprehension (BPVS receptive vocabulary and Robot narrative retell and comprehension) were not significantly correlated, ($r = .18, ns$), suggesting that as skills become more consolidated the two dimensions become less related.

4.3.4 Regression Analyses

Regression analyses were conducted to further examine the longitudinal relationships underpinning the acquisition of reading comprehension and their developmental trajectory within the SVR framework. A set of standard multiple regression analyses were performed to determine if early Nursery (T1) measures uniquely contributed to ability in the two SVR dimensions: decoding ability and language comprehension, one year later in Reception (T2) and single word reading and listening comprehension, at the end of Reception (T3). Secondly, a further set of standard multiple regression models were constructed to evaluate if Nursery (T1) measures uniquely contributed to reading comprehension and the two SVR dimensions of reading efficiency and language comprehension at the end of Year 1 (T4). Finally, a hierarchical regression model was built to evaluate whether Nursery (T1) measures predicted additional variance in Year 1 (T4) reading comprehension after controlling for concurrent T4 SVR dimensions of reading

efficiency and language comprehension. Analysis was performed using SPSS REGRESSION and SPSS EXPLORE for evaluation of assumptions.

In preparation for the analyses all variables were residualised for age (see section 2.6 for rationale). The exceptions were those variables with calculated standard scores (T1 non-verbal ability, T4 decoding efficiency and T4 reading comprehension). In the analyses, key measures at each time point were entered with the proviso that each of the predictors was significantly correlated (zero-order) with the criterion (otherwise they were excluded from the analysis). To reduce the number of predictor variables, composite scores were used for constructs with multiple measures in all analyses. Following each step in the analyses, residuals and influence statistics were explored to check and address any violation of assumptions of normality. Where a significant skew was found in the distribution of standardized residuals, further investigation was conducted to identify multivariate outliers. The outcome for each set of regression analyses is reported below.

4.3.4.1 Nursery (T1) predictors of Reception (T2) SVR dimensions

4.3.4.1.1 T1 cognitive measures to T2 decoding ability

A standard multiple regression analysis ($N = 80$) was carried out to investigate the degree to which Nursery (T1) cognitive measures accounted for unique variance in emergent decoding ability one year later in Reception (T2). Nursery (T1) measures of non-verbal ability, letter knowledge, print knowledge, phonological awareness, language skills and working memory were entered as independent variables. T2

decoding composite (letter knowledge and single word reading) was the dependent variable. Evaluation of assumptions and residual statistics revealed a normal distribution of standardized residuals and, with the use of a $p < .01$ criterion for Mahalanobis distance and a leverage criterion of .16, no outliers were identified. No cases had missing data. Results are presented in Table 4.5.

The results yielded a significant model, $F(6, 73) = 17.66$ $p < .001$ and an R^2 value of .59, suggesting that more than half of the variance in T2 decoding ability was predicted by the T1 cognitive factors. Evaluation of the coefficients indicated that T1 letter knowledge was the only unique predictor of T2 decoding ability. Inspection of the semi-partial correlations produced by the regression revealed that T1 letter knowledge accounted for 20% of unique variance in T2 decoding. T1 nonverbal ability, print knowledge, PA, language skills and working memory did not uniquely contribute to T2 decoding ability. However, in combination, the six T1 cognitive factors predicted a further 39% of shared variability in T2 decoding skills.

Table 4.5:
Multiple regression analyses predicting T2 decoding and linguistic comprehension at age 4

Variable	<i>B (SE B)</i>	β	
Outcome variable: Reception (T2) decoding (<i>N</i> = 80)			
T1 Nonverbal ability	0.02 (.03)	.06	.517
T1 Letter knowledge	0.61 (.10)	.61	< .001*
T1 Print knowledge	0.10 (.10)	.10	.289
T1 PA	-0.03 (.10)	-.03	.750
T1 Language skills	0.04 (.06)	.08	.426
T1 Working memory	0.11 (.12)	.14	.219
Total R^2 = .59*; $F(6, 73) = 17.66, p < .001$			
Outcome variable: Reception (T2) linguistic comprehension (<i>N</i> = 80)			
T1 Nonverbal ability	0.01 (.05)	.02	.825
T1 Letter knowledge	0.26 (.18)	.15	.170
T1 Print knowledge	-0.05 (.17)	-.03	.769
T1 PA	-0.06 (.19)	-.04	.734
T1 Language skills	0.54 (.10)	.56	< .001*
T1 Working memory	0.42 (.20)	.20	.043*
Total R^2 = .53*; $F(6, 73) = 13.57, p < .001$			

Notes: * $p < .05$; T1 = Time 1 (Nursery); T2 = Time 2 (Reception); PA = phonological awareness

4.3.4.1.2 T1 cognitive measures to T2 linguistic comprehension

A further standard multiple regression ($N = 80$) was carried out to investigate the degree to which Nursery (T1) cognitive measures accounted for unique variance in linguistic comprehension measured one year later in Reception (T2). Once again, T1 measures of non-verbal ability, letter knowledge, print knowledge, phonological awareness, language skills and working memory were entered as independent variables. T2 linguistic comprehension was the dependent variable. Evaluation of assumptions and residual statistics revealed one case with a standardized residual value of greater than 2.5; however, this was deemed acceptable as it constituted less than 5% of participants (Field, 2009). The overall

model showed a normal distribution of standardized residual values. Results are reported in Table 4.5.

The model was significant, $F(6, 73) = 13.57, p < .001$. A R^2 value of .53 suggested that more than half of the variability in T2 linguistic comprehension was predicted by T1 cognitive measures. Inspection of the coefficients showed that T1 language skill and T1 working memory capacity were both significant unique predictors of T2 linguistic comprehension. T1 non-verbal ability, letter knowledge, print knowledge and PA did not independently predict T2 linguistic comprehension. Examination of the semi-partial correlations revealed that T1 language skills uniquely predicted 18% of variance in T2 linguistic comprehension. T1 working memory accounted for a further small, but significant, unique contribution of 3% to variance in T2 linguistic comprehension. The T1 cognitive factors, in combination, accounted for a further 32% of shared variance in T2 linguistic comprehension.

4.3.4.2 Nursery (T1) predictors of end of Reception (T3) SVR dimensions

4.3.4.2.1 T1 cognitive measures to T3 single word reading

A standard multiple regression analysis ($N = 80$) was carried out to investigate the degree to which preschool (T1) cognitive measures accounted for unique variance in single word reading at the end of Reception (T3). Nursery (T1) measures of non-verbal ability, letter knowledge, print knowledge, PA, language skills and working memory were entered as independent variables. T3 single word reading was the dependent variable. Evaluation of assumptions and residual statistics revealed one

outlier with standardized residual greater than 3. Data from this participant was excluded and the analysis was rerun, leaving a sample size of 79. Results for this model revealed a normal distribution of standardized residuals and no further outliers were identified. No cases had missing data. Results are presented in Table 4.6.

Table 4.6:
Multiple regression analyses predicting T3 single word reading & listening comprehension at age 5

Variable	<i>B (SE B)</i>	<i>β</i>	
Outcome variable: End of Reception (T3) single word reading (<i>N</i> = 79)			
T1 Nonverbal ability	0.06 (.03)	.20	.032*
T1 Letter knowledge	0.40 (.10)	.41	< .001*
T1 Print knowledge	0.08 (.10)	.08	.413
T1 PA	0.24 (.10)	.24	.031*
T1 Language skills	-0.03 (.06)	-.05	.650
T1 Working memory	0.11 (.12)	.09	.356
Total $R^2 = .57^*$; $F(6, 72) = 15.84, p < .001$			
Outcome variable: End of Reception (T3) listening comprehension (<i>N</i> = 79)			
T1 Nonverbal ability	-0.06 (.03)	-.18	.104
T1 Letter knowledge	< 0.01 (.12)	< .01	.975
T1 Print knowledge	< 0.01 (.12)	< -.01	.982
T1 PA	0.14 (.12)	.15	.246
T1 Language skills	0.26 (.07)	.47	< .001*
T1 Working memory	0.28 (.14)	.23	.047*
Total $R^2 = .39^*$; $F(6, 72) = 7.70, p < .001$			

Notes: * $p < .05$; T1 = Time 1 (Nursery); T3 = Time 3 (end of Reception); PA = phonological awareness

Results yielded a significant model, $F(6, 71) = 16.42, p < .001$ and a R^2 value of .57. Evaluation of the coefficients indicated that T1 non-verbal ability, letter knowledge and PA independently provided unique contributions to T3 single word reading. Inspection of the semi-partial correlations showed that T1 letter knowledge was the strongest predictor, accounting for 9% of unique variance in T3 single word

reading. Both non-verbal ability and PA independently predicted a further unique 3% each in the variability of T3 single word reading. T1 print knowledge, language skills and working memory did not account for unique variance in T3 single word reading skills; however, in combination all six T1 factors contributed a further 42% of shared variance.

4.3.4.2.2 T1 cognitive measures to T3 listening comprehension

A further standard multiple regression ($N = 80$) was carried out to investigate the degree to which Nursery (T1) cognitive measures accounted for unique variance in listening comprehension at the end of Reception (T3). As for previous models, T1 measures of non-verbal ability, letter knowledge, print knowledge, phonological awareness, language skills and working memory were entered as independent variables. T3 listening comprehension was the dependent variable. Evaluation of assumptions and residual statistics revealed one case with a standardized residual value of less than -3. Data from this participant was excluded and the analysis was rerun. No further outliers were identified and the model showed a normal distribution of residual values. Results are reported in Table 4.6.

The model was significant, $F(6, 72) = 7.70, p < .001$ and yielded a R^2 value of .39. Examination of coefficients showed that T1 language skill and T1 working memory capacity were both significant unique predictors of T3 listening comprehension. Inspection of the semi-partial correlations revealed that T1 language skill was the strongest predictor of T3 listening comprehension, uniquely accounting for 12% of

variance. T1 working memory contributed a further, significant 3.5% of unique variance in T3 listening comprehension. T1 measures of non-verbal ability, letter knowledge, print knowledge and phonological awareness did not independently contribute to variance in T3 listening comprehension; however, in combination with T1 language and working memory, the T1 variables explained a further 23% of variance in T3 listening comprehension.

4.3.4.3 Autoregressive effects: T1 predictors of T3 SVR dimensions controlling for T2 decoding and language measures

Further examination of the role of T1 cognitive factors was undertaken to determine whether T1 factors continued to significantly contribute to the growth of T3 single word reading and listening comprehension after controlling for the autoregressive⁴ effects of T2 decoding and language comprehension. A hierarchical multiple regression model was built to establish whether the T1 predictors of T3 single word reading remained significant over and above T2 decoding. A second model was constructed to determine whether the T1 predictors of T3 listening comprehension remained significant after controlling for T2 linguistic comprehension. For both models, the autoregressor was entered at Step 1, and T1 variables were entered at Step 2. The results are reported in Table 4.7.

The first model investigated whether T1 predictors of T3 single word reading remained significant over and above T2 decoding ability. Entering T2 decoding at Step 1 resulted in a significant model, $F(1, 77) = 98.77, p < .001$ and a significant R^2

⁴ Autoregressive effects in the current study are not strictly autoregressors, as different measurement tasks were used at each time point. The aim was to control for abilities within the same construct at earlier time points.

value of .56. Entering T1 cognitive variables at Step 2 accounted for a significant, additional 10% of variance in T3 single word reading.

Table 4.7: Hierarchical regression models predicting T3 single word reading & listening comprehension controlling for T2 autoregressive factors

Variable	ΔR^2	$B (SE B)$	β	p
Outcome variable: End Reception (T3) single word reading ($N = 79$)				
<i>Step 1</i>	.56*			
T2 Decoding		0.74 (.08)	.75	< .001*
<i>Step 2</i>	.10*			
T2 Decoding		0.48 (.11)	.49	< .001*
T1 Nonverbal ability		0.05 (.03)	.16	.050*
T1 Letter knowledge		0.12 (.11)	.12	.296
T1 Print knowledge		0.02 (.09)	.02	.846
T1 PA		0.24 (.09)	.25	.010*
T1 Language skills		-0.04 (.05)	-.08	.418
T1 Working memory		0.04 (.11)	.03	.688
Total $R^2 = .66^*$; $F(7, 71) = 20.02$, $p < .001$				
Outcome variable: End Reception (T3) listening comprehension ($N = 79$)				
<i>Step 1</i>	.48*			
T2 Linguistic comprehension		0.41 (.05)	.69	<.001*
<i>Step 2</i>	.07			
T2 Linguistic comprehension		0.41 (.07)	.68	<.001*
T1 Nonverbal ability		-0.06 (.03)	-.18	.065
T1 Letter knowledge		-0.18 (.11)	-.18	.117
T1 Print knowledge		0.11 (.10)	.11	.279
T1 PA		0.25 (.11)	.25	.030*
T1 Language skills		-0.01 (.07)	-.01	.909
T1 Working memory		0.08 (.12)	.07	.533
Total $R^2 = .55^*$; $F(7, 71) = 12.13$, $p < .001$				

Notes: * $p < .05$; T1 = Time 1 (Nursery); T2 = Time 2 (Reception); T3 = Time 3 (end of Reception); PA = phonological awareness

The final model was significant, $F(7, 70) = 20.02$, $p < .001$. Evaluation of the coefficients showed that after controlling for T2 decoding, T1 letter knowledge became non-significant, suggesting that the unique contribution of T1 letter knowledge to T3 single word reading may be mediated by T2 decoding skills. In

contrast, non-verbal ability and T1 PA remained significant predictors of T3 single word reading over and above T2 decoding skills, suggesting that non-verbal ability and early PA skills continue to play a direct role in the growth of word reading skills.

The second model examined whether T1 predictors of T3 listening comprehension remained significant after controlling for T2 linguistic comprehension. Entering T2 linguistic comprehension at Step 1 resulted in a significant model, $F(1,77) = 69.63, p < .001$. A R^2 value of .48 suggested that T2 linguistic comprehension uniquely accounted for almost half of the variability in T3 listening comprehension. The addition of T1 cognitive factors at Step 2 accounted for a further, non-significant 7% of variance in T3 listening comprehension; however, the final model was significant, $F(7, 70) = 12.13, p < .001$. Results revealed that after controlling for T2 linguistic comprehension, T1 language skills and T1 working memory became non-significant, suggesting that their contribution to T3 listening comprehension may be mediated by T2 language skills. However, after controlling for T2 linguistic comprehension, T1 PA became a unique predictor of T3 listening comprehension, accounting for a small, but significant 3% of variance. This suggested that early PA skills not only continue to contribute directly to the growth in decoding ability, but also to the development of oral language skills.

4.3.4.4 Nursery (T1) predictors of end of Year 1 (T4) SVR dimensions

4.3.4.4.1 T1 cognitive predictors of T4 reading efficiency

A standard multiple regression analysis ($N = 80$) was carried out to investigate the degree to which Nursery (T1) cognitive measures accounted for unique variance in T4 reading efficiency (composite of timed single word reading and non-word decoding) at the end of Year 1 (T4). T1 measures of non-verbal ability, letter knowledge, print knowledge, phonological awareness, language skills and working memory were entered as independent variables. Evaluation of assumptions and residual statistics revealed normal distribution of residuals and no outliers. The model was significant, $F(6, 73) = 6.11, p < .001$ and yielded a R^2 value of .33. Results are presented in Table 4.8.

Table 4.8: Multiple regression analyses predicting T4 reading efficiency & language comprehension at age 6

Variable	$B (SE B)$	β	p
Outcome variable: Year 1 (T4) reading efficiency ($N = 80$)			
T1 Nonverbal ability	1.20 (.58)	.23	.041*
T1 Letter knowledge	6.97 (2.04)	.44	.001*
T1 Print knowledge	0.90 (1.94)	.06	.646
T1 PA	0.08 (2.06)	.01	.971
T1 Language skills	-0.75 (1.13)	-.08	.510
T1 Working memory	1.09 (2.35)	.05	.646
Total $R^2 = .33^*$; $F(6, 73) = 6.11, p < .001$			
Outcome variable: Year 1 (T4) language comprehension ($N = 79$)			
T1 Nonverbal ability	0.07 (.05)	.12	.234
T1 Letter knowledge	-0.04 (.19)	-.02	.847
T1 Print knowledge	0.26 (.18)	.16	.160
T1 PA	-0.15 (.19)	-.09	.440
T1 Language skills	0.43 (.11)	.48	< .001*
T1 Working memory	0.23 (.22)	.11	.301
Total $R^2 = .42^*$; $F(6, 73) = 8.74, p < .001$			

Notes: * $p < .05$; T1 = Time 1 (Nursery); T3 = Time 3 (end of Reception); T4 = Time 4 (end of Year 1); PA = phonological awareness

Evaluation of the coefficients revealed that non-verbal ability and T1 letter knowledge uniquely contributed to T4 reading efficiency. Investigation of the semi-partial correlations revealed that T1 letter knowledge was the strongest predictor accounting for 11% of the variance in T4 reading efficiency. Non-verbal ability accounted for a further, significant 4% of variance in T4 reading efficiency. T1 print knowledge, phonological awareness, language skills and working memory did not account for unique variance in T4 reading efficiency; however, in combination, the six T1 cognitive variables accounted for a further 18% of shared variance in T4 reading efficiency.

4.3.4.4.2 T1 cognitive predictors of T4 linguistic comprehension

A further standard multiple regression ($N = 80$) was carried out to investigate the degree to which Nursery (T1) cognitive measures accounted for unique variance in linguistic comprehension at the end of Year 1 (T4). Once again, T1 measures of non-verbal ability, letter knowledge, print knowledge, phonological awareness, language skills and working memory were entered as independent variables. Evaluation of assumptions and residual statistics revealed a normal distribution of standardized residual and no outliers. Results are reported in Table 4.8.

The model was significant, $F(6, 73) = 8.74, p < .001$ and resulted in a R^2 value of .42. Evaluation of coefficients showed that T1 language skill was the only significant unique predictor of T4 linguistic comprehension. Examination of the semi-partial correlations showed that T1 language skill accounted for 13% of variance in T4 linguistic comprehension. T1 measures of non-verbal ability, letter knowledge,

print knowledge, phonological awareness and working memory did not uniquely predict T4 linguistic comprehension; however, the combination of factors along with T1 language skill accounted for a further 29% of shared variance in T4 linguistic comprehension.

4.3.4.5 Autoregressive effects: T1 predictors of T4 SVR dimensions controlling for T3 decoding and listening comprehension

Further hierarchical regression analyses were performed to examine whether the T1 cognitive factors continued to directly contribute to the growth of word reading and language skills in Year 1, over and above Reception (T3) single word reading and listening comprehension. A hierarchical multiple regression model was built to establish whether the T1 predictors of T4 reading efficiency remained significant after controlling for T3 single word reading. A second model was constructed to determine whether the T1 predictors of T4 linguistic comprehension remained significant after controlling for T3 listening comprehension. For both models, the autoregressor was entered at Step 1, and T1 variables were entered at Step 2. Evaluation of assumptions and residual statistics for both models revealed normal distributions for each model. The results are reported in Table 5.9.

The first model investigated whether T1 predictors of T4 reading efficiency remained significant after controlling for T3 single word reading. Entering T3 single word reading at Step 1 resulted in a significant model, $F(1, 78) = 79.63, p < .001$ and a significant R^2 value of .51. At Step 2, the T1 variables accounted for a

small and non-significant change in R^2 ; however, the overall model was significant, $F(7, 72) = 11.75, p < .001$. Evaluation of the coefficients showed that with the addition of T3 single word reading, T1 letter knowledge became non-significant. T3 single word reading was the only unique predictor of T4 reading efficiency, suggesting that the unique contributions of T1 letter knowledge and non-verbal ability to T4 reading efficiency became indirect via by T3 single word reading.

Table 4.9: Hierarchical regression models predicting T4 reading efficiency and language comprehension controlling for T3 autoregressive factors

Variable	ΔR^2	$B (SE B)$	β	p
Outcome variable: Year 1 (T4) reading efficiency ($N = 80$)				
<i>Step 1</i>	.51*			
T3 Single word reading		11.34 (1.27)	.71	< .001*
<i>Step 2</i>	.03			
T3 Single word reading		10.36 (1.87)	.65	< .001*
T1 Nonverbal ability		0.66 (.50)	.13	.189
T1 Letter knowledge		2.40 (1.91)	.15	.213
T1 Print knowledge		0.66 (1.64)	.04	.688
T1 PA		-2.01 (1.78)	-.13	.262
T1 Language skills		-0.73 (.95)	-.08	.447
T1 Working memory		-0.15 (2.00)	.01	.940
Total $R^2 = .53^*$; $F(7, 72) = 11.74, p < .001$				
Outcome variable: Year 1 (T4) language comprehension ($N = 80$)				
<i>Step 1</i>	.35*			
T3 Listening comprehension		0.95 (.15)	.59	.001*
<i>Step 2</i>	.18*			
T3 Listening comprehension		0.67 (.16)	.42	.001*
T1 Nonverbal ability		0.10 (.05)	.19	.051
T1 Letter knowledge		< 0.01 (.17)	< .01	.986
T1 Print knowledge		0.19 (.17)	.12	.251
T1 PA		-0.29 (.18)	-.18	.110
T1 Language skills		0.30 (.10)	.34	.004*
T1 Working memory		0.05 (.20)	.03	.799
Total $R^2 = .53^*$; $F(7, 72) = 11.75, p < .001$				

Notes: * $p < .05$; T1 = Time 1 (Nursery); T3 = Time 3 (end of Reception); T4 = Time 4 (end of Year 1); PA = phonological awareness

The second model evaluated whether T1 predictors of T4 linguistic comprehension remained significant over and above T3 listening comprehension. At Step 1, T3 listening comprehension was entered, resulting in a significant model, $F(1, 78) = 42.61, p < .001$ and a R^2 value of .35. T1 cognitive variables entered at Step 2 accounted for a further, significant 18% of variance in T4 linguistic comprehension. The final model was significant, $F(7, 72) = 11.75, p < .001$. Results revealed that T3 listening comprehension was a unique predictor of T4 linguistic comprehension. T1 language skills remained a significant unique predictor of T4 linguistic comprehension over and above T3 listening comprehension. Inspection of the semi-partial correlations revealed that T1 language skill accounted for 6% of unique variance in T4 linguistic comprehension. Results suggested that early T1 language skills contributed to later T4 linguistic comprehension both directly and indirectly, via T3 listening comprehension.

4.3.4.6 Nursery (T1) predictors of end of Year 1 (T4) reading comprehension

A final standard multiple regression analysis ($N = 80$) was performed to investigate whether Nursery (T1) cognitive measures uniquely predicted reading comprehension at the end of Year 1 (T4). T1 measures of non-verbal ability, letter knowledge, print knowledge, phonological awareness, language skills and working memory were entered as independent variables. Evaluation of assumptions and residual statistics revealed a negative skew in distribution of residuals. Further investigation showed two cases with standardized residual values of less than -3. Data from these participants were excluded and the analysis was rerun, leaving a sample of 78. The model was significant, $F(6, 71) = 9.18, p < .001$ and the R^2 value

suggested that 44% of variability in T4 reading comprehension was predicted by T1 Nursery cognitive variables. Results are presented in Table 4.10.

Table 4.10:
Multiple regression analysis predicting T4 reading comprehension at age 6

Variable	<i>B (SE B)</i>	β	<i>p</i>
Outcome variable: Year 1 (T4) reading comprehension (<i>N</i> = 78)			
T1 Nonverbal ability	-0.04 (.29)	-.01	.904
T1 Letter knowledge	2.77 (1.00)	.33	.007*
T1 Print knowledge	-0.18 (.98)	-.02	.854
T1 PA	-0.15 (1.02)	-.02	.882
T1 Language skills	1.39 (.56)	.29	.015*
T1 Working memory	2.65 (1.15)	.25	.025*
Total R^2 = .44*; $F(6, 71) = 9.18, p < .001$			

Notes: * $p < .05$; T1 = Time 1 (Nursery); T4 = Time 4 (end of Year 1); PA = phonological awareness

Examination of the coefficients indicated that T1 letter knowledge, language skill and working memory were significant, unique predictors of T4 reading comprehension. Inspection of the semi-partial correlations revealed that T1 letter knowledge accounted for 6%, T1 language skills accounted for 5% and T1 working memory accounted for 4% of unique variance in T4 reading comprehension. T1 nonverbal ability, print knowledge and PA did not uniquely contribute to T4 reading comprehension. However, in combination, the six T1 cognitive factors predicted a further 29% of shared variability in T4 reading comprehension.

4.3.4.7 Autoregressive effects: T1 predictors of T4 reading comprehension controlling for T4 reading efficiency and language comprehension

The final hierarchical regression in these analyses was conducted to evaluate whether T1 cognitive measures continued to play a unique role in T4 reading comprehension performance over and above the two distinct SVR dimensions of word reading and linguistic comprehension. At Step 1, T4 reading efficiency and linguistic comprehension were entered. Evaluation of assumptions and residual statistics revealed a negative skew in the distribution of the standardized residuals. Two outliers with standardized residual values of less than -3 were identified and their data were excluded. The analysis was rerun with a sample of 78 and the resulting distribution of standardized residuals was normal. As in previous hierarchical regression analyses, T1 cognitive measures were entered at Step 2. Further evaluation of assumptions and residual statistics indicated a normal distribution of residuals and no further outliers were identified. No cases had missing data. Results are presented in Table 4.11.

The results at Step 1 yielded a significant model, $F(2, 75) = 33.64, p < .001$. The combination of T4 reading efficiency and T4 linguistic comprehension accounted for 47% of variability in T4 reading comprehension. The addition of T1 cognitive measures at Step 2 improved the model with a significant increase in R^2 value, suggesting that the combination of the T1 variables accounted for a further 11% of variance in T4 reading comprehension. The overall model remained significant, $F(8, 69) = 11.83, p < .001$.

Table 4.11: Hierarchical regression model predicting T4 reading comprehension controlling for T4 SVR dimensions

Variable	ΔR^2	$B (SE B)$	β	p
Outcome variable: Year 1 (T4) reading comprehension ($N = 77$)				
<i>Step 1</i>	.47*			
T4 Reading efficiency		0.18 (.05)	.33	< .001*
T4 Language comprehension		2.70 (.46)	.52	< .001*
<i>Step 2</i>	.11*			
T4 Reading efficiency		0.11 (.05)	.20	.047*
T4 Language comprehension		2.25 (.54)	.43	< .001*
T1 Nonverbal ability		-0.27 (.26)	-.09	.314
T1 Letter knowledge		2.14 (.95)	.25	.028*
T1 Print knowledge		-1.01 (.88)	-.12	.254
T1 PA		0.25 (.90)	.03	.786
T1 Language skills		0.45 (.54)	.10	.408
T1 Working memory		2.03 (1.02)	.19	.051
Total $R^2 = .58^*$; $F(8, 69) = 11.83, p < .001$				

Notes: * $p < .05$; T1 = Time 1 (Nursery); T4 = Time 4 (end of Year 1); PA = phonological awareness; SVR = Simple View of Reading (Gough & Tunmer, 1986)

Evaluation of the coefficients indicated that both T4 reading efficiency and T4 linguistic comprehension were significant predictors of T4 reading comprehension. Inspection of the semi-partial correlations produced by the regression revealed that T4 reading efficiency accounted for 10% of unique variability in T4 reading comprehension and T4 linguistic comprehension accounted for 24% unique variance. In combination, the two variables accounted for a further 13% of shared variance. Overall, the two variables accounted for a total of 47%, less than half, of the variability in reading comprehension performance, suggesting that more than half of variance remained unexplained by the SVR dimensions.

At Step 2, T1 letter knowledge remained a significant predictor of T4 reading comprehension over and above T4 reading efficiency⁵, suggesting that the unique contribution of T1 letter knowledge to T4 reading comprehension may be partially mediated by T4 reading efficiency, but that it also remains a direct predictor. In contrast, the unique contribution of T1 language skills to T4 reading comprehension became non-significant after controlling for T4 linguistic comprehension, suggesting that the relationship between T1 language skills and T4 reading comprehension appears to be mediated by T4 linguistic comprehension. T1 working memory remained marginally significant over and above the T4 variables, suggesting that early working memory capacity may uniquely contribute to the acquisition of reading comprehension over and above the dimensions of the SVR.

⁵ For brevity, the reported analysis controlled for both T4 SVR dimensions simultaneously.

However, separate hierarchical regressions were conducted to control for the T4 SVR dimensions independently in order to determine the effects of each dimension independently. The overall pattern remained the same as controlling for both dimensions, but the results supported the suggestion that T1 letter knowledge may be mediated by T4 word reading efficiency and T1 language may be mediated by T4 linguistic comprehension, as T1 letter knowledge remained a strong significant predictor when controlling for T4 language comprehension and, vice versa, T1 language remained a strong predictor when controlling for T4 word reading efficiency. T1 working memory remained significant when controlling for T4 reading or language, suggesting a direct, unique contribution to T4 reading comprehension over and above both SVR dimensions.

4.4 Discussion

The current longitudinal study initially assessed a range of cognitive skills, in a group of typically developing three to four year-old pre-readers and followed their progress in emergent literacy to the acquisition of reading comprehension at six years old. Children completed a battery of assessments during their second term at Nursery (T1) to measure non-verbal ability, letter knowledge, phonological awareness (PA), oral language (receptive vocabulary, expressive and receptive language), print knowledge and working memory. Children were reassessed one year later, during the second term of Reception (T2), and again, four months later at the end of the academic year (T3). The final assessment was conducted one year later, at the end of Year 1 (T4), after children had completed two years of fulltime education.

The study examined the acquisition of reading comprehension within the framework of the Simple View of Reading (SVR: Gough & Tunmer, 1986; Hoover & Gough, 1990), which proposes that reading comprehension is the product of word reading (accuracy and efficiency) and oral language comprehension. In order to determine the degree to which the SVR adequately explains the acquisition of reading comprehension, outcome measures representing the two SVR dimensions were taken at the end of Reception and at the end of Year 1. Children's single word reading and listening comprehension were measured at the end of the Reception year. One year later, at the end of Year 1, children were assessed in word reading efficiency and linguistic comprehension (receptive vocabulary and narrative retell and comprehension). Additionally, at the end of Year 1, children completed a standardized reading comprehension task.

Research investigating the acquisition of reading comprehension in very young, typically developing children is limited. A number of studies have examined precursors of emergent literacy and listening comprehension in preschool children (e.g., Florit, Roch, & Levorato, 2011; Lepola, Lynch, Laakkonen, Silvén, & Niemi, 2012), and there is a wealth of research examining the acquisition of word reading skills (e.g., Ehri, 2005; Storch & Whitehurst, 2001; Tunmer & Chapman, 2012b). However, to my knowledge, there is, to date, no study combining these factors to investigate the early predictive pathways from pre-reading cognitive skills at three years old to reading comprehension at six years old, in a UK sample of typically developing, middle-class children.

4.4.1 Precursors: Early relationships and stability of measures

Assessing very young children raises potential concerns about the reliability of measures. Preliminary analysis revealed moderate to strong, significant correlations between the measures within the same constructs, across the three-year study, suggesting that tasks were reliable and that individual differences remained relatively stable across the early years. Previous research has suggested that there is a high level of continuity in cognitive ability through these early years (Lonigan, Burgess, & Anthony, 2000; Storch & Whitehurst, 2002) and a considerable degree of overlap and shared variance between code-related and language skills (Dickinson & McCabe, 2001; Kendeou et al., 2009b; National Institute of Child Health and Human Development (NICHD), 2005). Results from the current study extended this research to a younger sample to provide evidence that these inter-relationships can also be seen in three year-old children.

Correlational analyses revealed significant relationships between children's preschool code-related skills (letter knowledge, PA and print knowledge) and oral language skills at three years old. Additionally, preschool code-related skills and language ability significantly correlated, longitudinally, with both measures of the SVR (single word reading and listening comprehension) at the end of Reception, when children were five years old.

At the end of Year 1, one year later, the relationships between code-related skills and language ability changed, supporting previous research that suggested that cognitive precursors of emergent literacy contribute in varying degrees, depending on the developmental stage (Storch & Whitehurst, 2002; Whitehurst & Lonigan, 1998). All preschool variables significantly correlated with T4 reading comprehension; however, there was a distinction between skills underpinning each dimension of the SVR (T4 word reading efficiency and T4 linguistic comprehension), supporting previous research that has reported that both skill sets make independent, unique contributions to reading comprehension (Kendeou et al., 2009b; Storch & Whitehurst, 2002). Additionally, at T4, the relationship between word reading efficiency and linguistic comprehension was non-significant, adding support to the independence of the two SVR domains (Gough & Tunmer, 1986; Hoover & Gough, 1990; Tunmer & Chapman, 2012a). Preschool letter knowledge was the strongest correlate of word reading efficiency, but preschool oral language (receptive vocabulary, expressive language and receptive language) did not significantly correlate with word reading efficiency. Preschool language was the strongest correlate of linguistic comprehension (composite of receptive vocabulary and narrative comprehension) at the end of

Year 1; however, preschool letter knowledge also significantly correlated with the vocabulary aspect of T4 language composite measure (though not with the narrative comprehension aspect). Preschool PA and print knowledge were both significantly related to Year 1 word reading efficiency and linguistic comprehension. The results suggested a degree of inter-relation remained between the two SVR dimensions. However, in contrast to previous research that has suggested that vocabulary is the link between the dimensions through its contribution to word reading (Kendeou et al., 2009b; Tunmer & Chapman, 2012a), these results suggested that early code related skills (letter knowledge, print knowledge and PA) are important for the growth of vocabulary in the very early years. Early vocabulary and language skills were not significantly related to later word reading efficiency. As expected, preschool working memory was also significantly correlated to all code-related and language skills across all time points, with one exception: the relationship between preschool working memory and Year 1 word reading efficiency was only marginally significant. However, other later measures of working memory (T2 and T4) were both significantly related to word reading efficiency, supporting previous research that has found working memory is important for word reading in younger children (Blair & Rizza, 2007; Savage, Lavers, & Pillay, 2007; Welsh et al., 2010).

Regression models were constructed to examine predictive relationships from preschool precursors to the acquisition of reading comprehension. In general, results supported the SVR model (Gough & Tunmer, 1986; Hoover & Gough, 1990), where distinct skill sets underpin each of the two dimensions: word reading and linguistic comprehension. As proposed by the SVR, reading comprehension was

uniquely predicted by both word reading efficiency and linguistic comprehension. An overall summary of the findings is represented in schematic form in Figure 4.1.

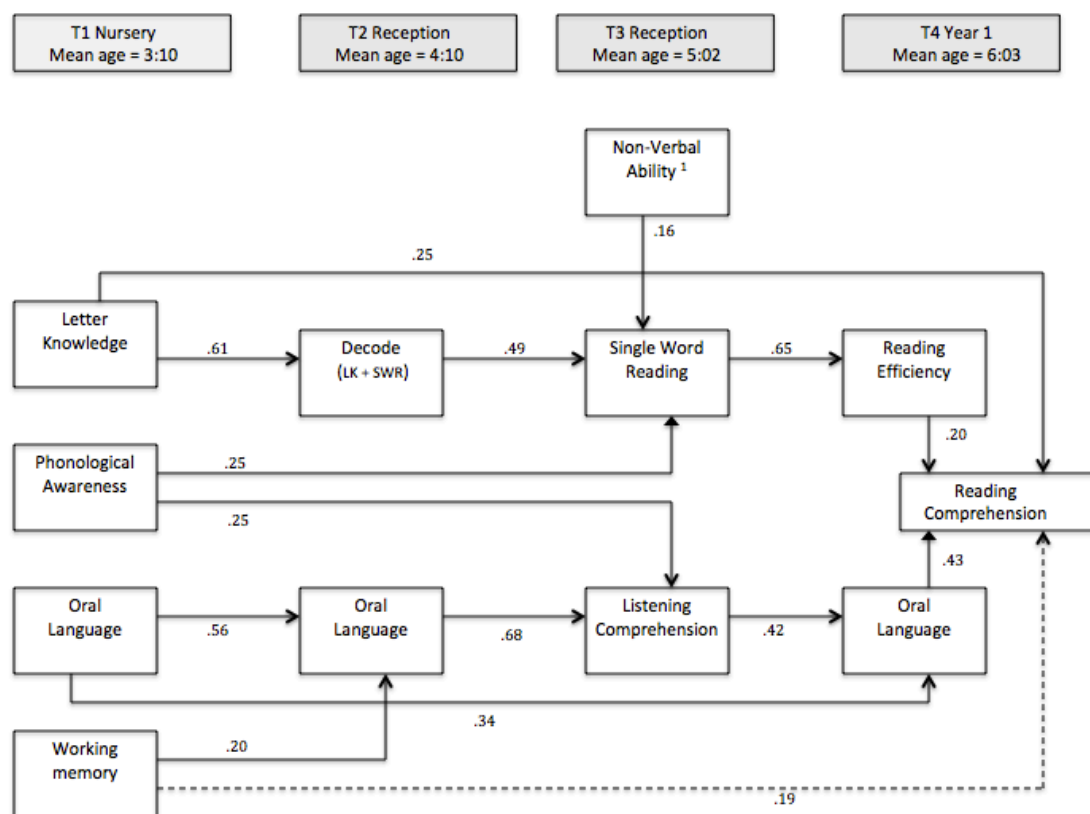


Figure 4.1: Model showing relationships between pre-reading skills, later emergent literacy skills, and early reading comprehension controlling for age and non-verbal ability
Notes: Values are standardized coefficients from exploratory regression analyses; dashed line represents marginal significance $p = .051$; solid lines represent significance $p < .05$; LK = letter knowledge; SWR = single word reading; ¹ Non-verbal ability was measured at T1

Within regression models, age, non-verbal ability and autoregressive effects of earlier decoding and oral language were controlled. Results support previous research (Kendeou et al., 2009b; Storch & Whitehurst, 2002; Tunmer & Chapman, 2012a; van den Broek et al., 2009) and extend to a younger sample, suggesting that there are two separate pathways from preschool (aged three years), pre-reading skills to the acquisition of reading comprehension at the end of Year 1 (aged six

years). One pathway supported later word reading efficiency through the development of letter knowledge and single word reading, and the other supported later linguistic comprehension through the development of a range of oral language skills including vocabulary and listening comprehension. Print knowledge did not uniquely contribute to either pathway; however, PA uniquely contributed to both pathways.

Non-verbal ability only made a unique contribution to Reception single word reading and, surprisingly, working memory significantly accounted for variance in early language skills, but not decoding and word reading. Interestingly, working memory also made a marginally significant direct and unique contribution ($p = .051$) to Year 1 reading comprehension over and above word reading efficiency and language comprehension.

4.4.2 Are the dimensions of the SVR distinct?

Correlation analysis revealed significant relationships between preschool code-related skills (letter knowledge, print knowledge and PA) and oral language, adding to previous evidence that language is closely related to the development of decoding and phonological skills in the very early school years (Dickinson & McCabe, 2001; NICHD, 2005). Significant correlations between preschool letter knowledge and oral language at T1 and between Reception decoding (letter knowledge and single word reading) and oral language at T2 demonstrated that the two SVR dimensions are linked at these very early stages of literacy acquisition. A weaker, but significant correlation was found at T3 between single

word reading and listening comprehension; however, the correlation between word reading efficiency and linguistic comprehension at T4 was non-significant. These results supported previous research with Grade 2 children that suggests the two SVR dimensions become distinct once word reading and language comprehension become better established (Kendeou et al., 2009b; Lonigan et al., 2000; Storch & Whitehurst, 2002). In the current study children's passage reading comprehension was examined a year earlier (aged 6 years) than the majority of previous studies (e.g., Storch & Whitehurst, 2002), therefore it provides further evidence for the distinction between the two dimensions of the SVR, even at this earlier time.

The high degree of inter-relation between preschool cognitive variables and the relative stability of individual differences would suggest that growth in all preschool variables may directly contribute to the development of word reading and language skills underpinning reading comprehension. However, results from regression analyses suggested that there were two *independent* predictive pathways (one indexing decoding skills and the other indexing oral language skills) from preschool cognitive precursors to the acquisition of reading comprehension (see schematic representation in Figure 4.1). These findings support and extend previous evidence of independent pathways (Kendeou et al., 2009b; Storch & Whitehurst, 2002) to a younger sample to demonstrate that the foundation of separate skill sets underpinning the development of reading comprehension can be found in very young pre-readers. The results add to growing evidence suggesting that development and growth through the early

years in *both* skill sets is equally crucial to emergent literacy and the acquisition of reading comprehension (e.g., Bianco et al., 2012; Paris & Paris, 2003).

Correlational studies cannot typically express issues of causality; however, the longitudinal design of the current study, starting before children acquired literacy skills, lends itself to the suggestion that the precursor skills identified in this study are causal antecedents to reading comprehension skill. This is extremely important, not only theoretically, but also practically, in terms of early identification of children likely to struggle with reading comprehension, and also for informing future interventions for reading comprehension by providing evidence that these early skills should be targeted.

The developmental pathways appeared to be independent with one notable exception; preschool PA significantly contributed to both word reading *and* language pathways. The contribution of PA to the development of decoding skills is well established (Castles & Coltheart, 2004; Hulme, Bowyer-Crane, Duff, & Snowling, 2012; Melby-Lervåg, Lyster, & Hulme, 2012). Surprisingly, PA did not make a unique contribution until the end of Reception, when it significantly predicted variance in single word reading and listening comprehension. It may be that unique variance was not found at earlier time points due to the high degree of shared variance; alternatively, phonological skills may become more crucial for blending and manipulating sounds to construct words for reading and speaking once a sufficient level of letter knowledge has been achieved (Storch & Whitehurst, 2002; Whitehurst & Lonigan, 1998). Although single word reading was measured at T2, to form a decoding composite with letter knowledge, children's word

reading ability was limited (mean = 4.86 words) and there was still a high level of variability in letter knowledge; however, by the end of Reception most children knew all letter sounds.

The role of PA in the development of listening comprehension is less clear.

Phonological awareness has been associated with concurrent and later listening comprehension (Dufva, Niemi, & Voeten, 2001; Sénéchal, 2006), but a direct unique contribution from PA to listening comprehension has not been reported. However, some support was found in a Finnish study that reported PA training improved later listening comprehension in a sample of seven year old 'at risk' readers (Poskiparta, Niemi, & Vauras, 1999). Dufva et al. (2001) found that phonological memory, but not PA, directly contributed to listening comprehension in a Finnish sample of six year olds. More recent research has suggested that listening comprehension develops relatively independently from phonological skills (Lynch et al., 2008; Lepola et al., 2012). Also, other studies have suggested that oral language skills predict phonological skills rather than vice versa (NICHD, 2005; Storch & Whitehurst, 2002). In contrast, the current study found that PA skills at three years significantly predicted listening comprehension at five years old. Due to a paucity of research in this area, and the young age of this sample, it is difficult to determine whether early phonological skills contributed to later listening comprehension due to enhanced PA per se or whether early ability was a proxy measure for other phonological processing, e.g., phonological memory. Further research is needed to clarify these relationships. However, it is important to note that the focus on phonics instruction in the current early years curriculum may benefit comprehension abilities, in addition to developing word-reading skills.

Recently, it has been proposed that although the SVR model is fundamentally a two-component model, the assumption of independence between the dimensions should be amended to reflect a relationship from linguistic comprehension to word reading ability (Tunmer & Chapman, 2012a). The current study did not find evidence to support a direct link between word reading and linguistic comprehension. However, Tunmer and Chapman (2012a) based their review of the model on data obtained from a sample of seven year olds. Children in the current study were only six years old at the final assessment point, therefore the contribution from oral language skills to word reading may develop once word reading is more fluent and efficient. However, as noted above, PA did directly contribute to word reading and listening comprehension when children were aged five years, therefore PA may be the link between the distinct skill sets underpinning the SVR dimensions in the very early years.

4.4.3 The role of preschool decoding in early reading comprehension

The role of early letter knowledge, PA and print knowledge in emergent reading ability has been well established (for meta-analyses see Castles & Coltheart, 2004; Hecht, Burgess, Torgesen, Wagner, & Rashotte, 2000; Melby-Lervåg et al., 2012; Piasta & Wagner, 2010). In the current study, preschool letter knowledge was a significant predictor of later single word reading and reading efficiency, albeit indirectly after accounting for autoregressive effects. Results add further evidence for the predictive relationship between early letter knowledge and later reading ability at the end of the first and second grades (Catts, Fey, Zhang, & Tomblin, 2001; Puolakanaho et al., 2007; Schatschneider et al., 2004). Interestingly,

preschool letter knowledge also made a significant unique contribution to reading comprehension over and above word reading efficiency. Catts et al. (2001) found that early performance of letter knowledge at five years made a significant contribution to predicting the risk of reading comprehension deficits in the 2nd grade at seven years. In the current study, the direct relationship between preschool letter knowledge at three years and later reading comprehension at six years may reflect that word reading remains an effortful process requiring a high degree of decoding (Perfetti & Stafura, 2014). Alternatively, it may represent the stability of individual differences in cognitive abilities through the early years, such that advantages are gained through early competencies (Schatschneider et al., 2004). Otherwise, it may be that enhanced performance in letter knowledge at three years indexed other factors, such as home literacy effects (see Chapter 3 for discussion of HLE), which subsequently contribute to enhanced performance in reading comprehension.

In the current study, print knowledge did not account for unique variance in reading comprehension or either of the SVR dimensions, in line with previous research (Hecht et al., 2000). Hecht et al. (2000) examined the contribution of print knowledge in the growth of decoding and reading comprehension skills from kindergarten (aged five years) to fourth grade (aged 10 years). They reported that print knowledge made a significant unique contribution to decoding in Grade 2 and reading comprehension in Grade 3; however there was no significant contribution to either skill in Grade 1 (aged 6 years).

4.4.4 The role of preschool oral language in early reading comprehension

The role of oral language in the acquisition of reading comprehension has remained relatively unexplored. Research has suggested that decoding skills are the most influential precursors of early reading comprehension and broader language skills become more influential after Grade 2 (Kendeou et al., 2009b; Vellutino et al., 2007). However, other research has suggested that the full contribution of language skills may be underestimated due to use of limited language measures (Dickinson, Golinkoff, & Hirsh-Pasek, 2010) and that narrative skills contribute to reading comprehension at an earlier age than generally discussed in the literature (Bianco et al., 2012). Results from the current study support these latter views and provides evidence that richer preschool language measures (receptive vocabulary and language skills) uniquely accounted for a similar degree of variance in early reading comprehension as letter knowledge. Aged six years, children's linguistic comprehension (receptive vocabulary, narrative retell and narrative comprehension) uniquely accounted for 24% of variability in concurrent reading comprehension. In contrast, word reading efficiency accounted for 10% of variance. At this early stage of reading, decoding ability may still be a limiting factor for word reading, and, indeed, preschool letter knowledge also significantly and directly contributed to reading comprehension, suggesting that shared variance between decoding skills may have reduced the unique contribution from word reading efficiency. Nevertheless, the results demonstrated that oral language played a crucial role in the acquisition of reading comprehension, before word reading has become fully fluent and efficient.

Recent research has investigated the early preschool precursors of listening comprehension (Florit, Roch, Altoè, & Levorato, 2009; Lepola et al., 2012). In general, results from the current research supported previous findings. Similar correlations were demonstrated between receptive vocabulary and listening comprehension (Florit et al., 2009) and regression analysis showed that preschool language skills uniquely contributed to listening comprehension (Sénéchal et al., 2006). In contrast to Sénéchal et al. (2006), where receptive vocabulary was the only language measure, the richer measure of language used in this study accounted for greater variance in listening comprehension. Preschool language accounted for 12% unique variance in T3 listening comprehension (compared to 6% in Sénéchal et al., 2006); however, this relationship failed to reach significance after controlling for the autoregressive effects of T2 language. T2 language subsequently accounted for 48% of variance in T3 listening comprehension.

As expected, listening comprehension uniquely predicted T4 linguistic comprehension. However, interestingly, preschool language skills also remained a significant predictor over and above T3 listening comprehension. This direct relationship provided further evidence that it is crucial to consider language skills from a broad perspective. Results suggest that listening comprehension, vocabulary and narrative skills all uniquely contribute to later reading comprehension, via the linguistic comprehension dimension of the SVR.

4.4.5 The role of working memory in reading comprehension

Past research has reported that executive function, including working memory, predicted variance in letter knowledge, word reading and vocabulary (McClelland

et al., 2007). Additionally, other studies have found that working memory predicts reading achievement (Blair & Razza, 2007; Gathercole, Alloway, Willis, & Adams, 2006). In contrast, this study found that preschool working memory uniquely predicted early Reception (T2) language skills, but not decoding skills. Correlation analysis demonstrated a strong relationship between working memory and both letter knowledge and PA. The strong relationship between these variables suggested a high degree of shared variance, which may have accounted for the lack of unique contribution made by working memory to T2 decoding. This account supported previous research that has suggested that working memory and PA are closely related through the early stages of emergent literacy (Alloway, Gathercole, Willis, & Adams, 2004; Cutting & Deckla, 2001). Working memory was strongly correlated with concurrent PA at all time points, although less so in Year 1 (T4). Additionally, it was significantly correlated with all concurrent oral language measures, supporting research that it supports both dimensions of the SVR (Welsh et al., 2010).

Regression analyses found working memory contributed limited unique variance, possibly due to the high level of shared variance with other preschool variables. Alternatively, the working memory tasks may not have been sufficiently sensitive in measuring a range of individual differences. Young children have limited working memory capacity and the demands of the tasks were challenging, resulting in a somewhat binary distribution, possibly suggesting that performance may have reflected children's ability to follow complex instructions as much as their working memory capacity. In the absence of sensitive working memory tasks, it may be that, from their close relationship, PA could provide a proxy measure of

working memory capacity. Other research has suggested that the close relationship between PA and working memory diverges at a later stage, once decoding becomes less effortful and PA skills are less crucial (Savage et al., 2007), but in the early stages a bidirectional relationship may make it difficult to separate their effects. PA tasks are relatively easy to administer to young children and these results suggest that performance in PA assessments may be helpful in measuring the working memory capacity of preschool children.

Interestingly, preschool working memory did make a marginally significant, unique contribution to Year 1 reading comprehension over and above the two SVR dimensions. This finding is in line with research with older primary school children, where working memory has been found to predict reading comprehension over and above word reading, vocabulary and verbal ability (Cain et al., 2004a). Alternatively, it may reflect long-term advantages gained through early acquisition of higher-order cognitive skills (see following chapter for further discussion).

4.4.6 Does the SVR account for the acquisition of reading comprehension?

The findings from the current study, in general, support the SVR account of reading comprehension (Gough & Tunmer, 1986; Hoover & Gough, 1990). Two distinct pathways from pre-reading cognitive abilities to the acquisition of reading comprehension were identified. Both pathways ultimately and independently contributed to reading comprehension, one pathway through word reading efficiency and the other through linguistic comprehension. Results from the

current study add support to previous research that found two independent pathways from pre-reading cognitive skills to later reading comprehension (Kendeou et al., 2009b; Storch & Whitehurst, 2002). Additionally, the current study adds to existing knowledge in two important ways. Firstly, children were initially assessed at three years old, providing evidence that pre-reading cognitive abilities underpinning reading comprehension can be reliably assessed in younger children as they begin their preschool education. This evidence not only has important practical implications for the early identification of children who may be at risk of future reading comprehension problems, but also it provides valuable knowledge for informing early years literacy instruction for typically developing populations. Secondly, children's passage reading comprehension was assessed at six years old, a year earlier than typically measured in the literature. Both novel aspects extend the SVR model of reading comprehension to a younger population.

At the end of Year 1, when children were six years old, the two dimensions of the SVR (reading efficiency and linguistic comprehension) accounted for 47% of variability of reading comprehension. In combination, preschool variables accounted for a further, significant 11% of variance in reading comprehension over and above the developing pathways of word reading and language skills, suggesting that early pre-reading competencies continue to have a direct influence through the acquisition period of reading comprehension. The contribution of these early abilities may reflect that reading is still an effortful process and early competencies benefit beginner readers. Overall, these findings suggest that the SVR provides a useful general framework for understanding the foundation and development of cognitive abilities underpinning the acquisition of reading

comprehension. However, it may be too simple to fully account for the *acquisition* of reading comprehension. Early PA contributed to both word reading and language pathways, suggesting that phonological processes may link the two SVR dimensions through the development of emergent literacy. Also a considerable degree of variance in reading comprehension remained unexplained and the contribution of additional early cognitive abilities beyond word reading and language comprehension should be considered as additional components of the SVR.

4.4.7 Limitations

Assessing young pre-readers before they experienced formal literacy instruction was one of the main strengths of the current longitudinal study; however identifying reliable, age appropriate tasks was challenging. At three to four years old, there was a high degree of shared variance between children's cognitive abilities; therefore, some tasks that were selected to avoid floor or ceiling effects may not have been sufficiently sensitive to differentiate between cognitive skills. Children in the current study were initially assessed in a wide range of cognitive abilities; therefore, they completed an extensive battery of tasks. To limit demands on the children, assessment sessions were restricted in number and length; resulting in some variables being measured at a single time. However, during these early years, children's development may be uneven and episodic and highly influenced by their environment (Shepard, Kagan, & Wurtz, 1998); therefore, it may have been more reliable to measure children's abilities within each construct through a variety of assessments over different days.

Composite measures were computed for some variables in the current study with the aim of achieving a richer measure of the relevant constructs (Dickinson et al., 2010); however, greater reliability may have been achieved if similar measures had been consistently used. For example, listening comprehension was only measured at the end of reception, when children were five years old and narrative comprehension at the end of Year 1. If adaptations of listening comprehension and narrative comprehension were measured at each time point, along with receptive and definitional vocabulary, the reliability and validity of oral language skills may be further improved. Measuring children's higher order executive function ability proved to be particularly challenging. Previous research has reported links between executive function and emergent literacy (Blair & Rizza, 2007; McClelland et al., 2007; Welsh et al., 2010). The current study did establish relationships between working memory and emergent literacy. However, surprisingly, measures of cognitive inhibition failed to demonstrate significant relationships, though the tasks have been previously used with this age group (Carlson & Moses, 2001; Devine & Hughes, 2014). This result may have been due to the insensitivity of the tasks (several tasks were close to ceiling) and further research is required to establish reliable measures of executive function for these very young children.

Children in the current study were an opportunity sample from mainstream schools and from middle class backgrounds. Therefore, the results may not generalize to children from different SES backgrounds, or indeed to children with learning difficulties. Considering the potentially high attrition rate within longitudinal research with young children (e.g., Hood, Conlon, & Andrews, 2008),

the total sample in the current study was satisfactory. However, a larger sample would have allowed the use of more powerful analysis techniques.

Research has shown that the contribution of different cognitive abilities changes through the developmental pathways of emergent literacy (Storch & Whitehurst, 2002; Whitehurst & Lonigan, 1998). At six years, children were very young for reading comprehension assessments. Although standardized tests were used to measure word reading efficiency and reading comprehension, it is important to establish the relationship between those measures and reading comprehension through the next years, once word reading becomes more accurate and efficient. To fully understand the contribution of preschool cognitive abilities to later reading comprehension, it is vital to follow the longitudinal progress of these children until they become efficient, independent readers.

4.4.8 Conclusion and Implications

In summary, the results of the current study have extended knowledge of the acquisition of reading comprehension. Early data, when children were three years old, extended previous research that reported strong links between preschool code-related variables (letter knowledge, PA, print knowledge) and oral language skills (Kendeou et al., 2009b; Storch & Whitehurst, 2002) to a younger UK sample. Further analyses revealed that there were two separate predictive pathways from early preschool variables to the acquisition of reading comprehension at the end of Year 1, supporting the two-component design of the SVR model (Gough & Tunmer, 1986; Hoover & Gough, 1990; Tunmer & Chapman, 2012a). One pathway led to

word reading efficiency and the other to linguistic comprehension, both of which independently contributed unique variance in reading comprehension when children were six years old.

Crucially, evidence suggested that both pathways are influential, even at this very young age. Previous research has suggested that decoding and word recognition limits reading comprehension in the early years and the contribution from oral language skills becomes more important once word reading has become adequately efficient (Vellutino et al., 2007). However, results from the current study support the view that oral language is equally critical at a much earlier stage in the developmental trajectory (Bianco et al., 2012; Paris & Paris, 2003). Also, it was evident that richer measures of language reflect the contribution of oral language skills more effectively than vocabulary measures alone. The findings of the current study showed that a broad range of language skills (vocabulary, expressive and receptive language skills and listening comprehension) independently accounted for unique variance in later reading comprehension, therefore, it is essential to nurture all aspects of language.

In line with previous research, the results suggested that there is relative stability in individual differences and a high degree of shared variance in the early years (Kendeou et al., 2009b; Storch & Whitehurst, 2002). The current study provided further evidence that cognitive abilities underpinning reading development can be reliably assessed in young preschool pre-readers (Puolakanaho et al., 2007). However, it is challenging to find appropriate tasks for these young children and further research is needed to unravel the validity of assessment tasks, as it is

possible that, due to the high level of shared variance, some tasks index a range of cognitive abilities. For example, preschool phonological awareness was found to contribute to both word reading and language pathways and, considering its high degree of correlation with working memory and phonological memory, it may be indexing memory rather than PA per se. However, understanding the nature of these tasks may prove to be extremely useful, as measuring higher-order cognitive tasks in very young children is challenging and establishing proxy measures may be useful in the assessments of young pre-readers.

Overall, the current study extended the SVR pathways to a younger population, providing opportunity to highlight earlier markers of potential reading deficits. In general, the SVR provides a useful framework to examine the origins of reading comprehension, with the caveat that the model may be too simple and does not explain all of the variance in reading comprehension. Growing evidence has shown that children's reading problems can be prevented through early intervention (Torgesen, 2000; Vellutino et al., 1996). Therefore, the findings of the current study add crucial evidence to show that assessing preschool children, before they begin formal literacy instruction, may provide important indications of later emergent reading comprehension ability.

Chapter 5 Theory of mind and reading comprehension

5.1 Introduction

The Simple View of Reading (SVR; Gough & Tunmer, 1986; Hoover & Gough, 1990) provides a broad framework for conceptualising the complex nature of reading comprehension. The SVR proposes that reading comprehension is the product of decoding skills and linguistic comprehension. Each of the two dimensions is considered to be representative of an interaction of underlying skills and processes, but these processes contribute to one or other of the distinct dimensions. There is a wealth of empirical evidence demonstrating that a combination of decoding ability and linguistic comprehension skills account for a large percentage of variance in reading comprehension (Adlof, Catts, & Little, 2006; Conners, 2009, Johnston & Kirby, 2006). However, more recently, it has been suggested that the Simple View may be too simple (Conners, 2009; Johnston & Kirby, 2006; Seigneuric & Ehrlich, 2005; Tunmer & Chapman, 2012a). In particular, researchers are now considering the amount of variance in reading comprehension that remains unexplained by decoding and linguistic comprehension skills (Kirby & Savage, 2008) and has prompted the investigation of a third component to be added to the model.

Some researchers have suggested speed of processing, naming speed and writing ability as possible candidates (Adlof et al., 2006; Johnson, Jenkins, & Jewell, 2005; Johnston & Kirby, 2006; Joshi & Aaron, 2000). However, evidence from these studies has been mixed and, although it is possible that processing speed may be a factor of reading comprehension ability, the exact nature of its contribution to the

SVR remains unclear. Other researchers have examined the role of executive function in reading comprehension (Conners, 2009; Oakhill & Cain, 2012; Savage, Cornish, Manly, & Hollis, 2006; Seigneuric & Ehrlich, 2005). Though some evidence has shown that working memory, in particular, plays a role in reading comprehension in older primary school children (Cain, Oakhill, & Bryant, 2004a)(see 1.5.1 for more details), the current study shows this direct relationship becomes marginal after controlling for the dimensions of the SVR, at least in younger children (see 4.4.5). As such, results suggest that working memory does indeed contribute to reading comprehension, but its contribution may be via the word reading and linguistic comprehension components as suggested by the SVR.

More promising research has reported that attentional control (the ability to inhibit irrelevant responses and initiate alternative responses) accounts for variance in reading comprehension after controlling for language comprehension, decoding, processing speed and verbal short-term memory (Conners, 2009). The author suggests that this aspect of executive function should be considered as a third component of the SVR; arguing that attentional control might contribute to reading comprehension through its role in the higher-order comprehension process of detecting and repairing comprehension failures.

Importantly though, other researchers propose that this type of strategy, along with locating information, finding main ideas, determining text structure and using visual cues are essentially *metacognitive processes* (Kirby & Savage, 2008).

Metacognitive processes require thinking about aspects of one's thinking, which may draw on executive function abilities, but go beyond them. Specifically, Kirby

and Savage (2008) suggest that these strategies are more relevant to reading comprehension than language comprehension, due to the representational nature of text that remains visible to the reader. They argue that the SVR does not address the role of these metacognitive strategies in reading comprehension.

The current study aimed to address this issue and investigate whether metacognitive ability accounts for variance in later reading comprehension over and above the two dimensions of the SVR. Metacognition relates to higher order thinking, involving not only dynamic control over active cognitive processes, but also reflective insight about these processes (Flavell, 1987; Kuhn, 2000). One candidate of metacognition in young children is their theory-of-mind ability (Flavell, Green, & Flavell, 2000).

Theory of mind broadly involves the ability to impute mental states such as beliefs, desires and intentions to oneself and to others in order to explain and predict behaviour (Premack & Woodruff, 1978; see Doherty, 2009 for overview). A crucial milestone in this development occurs when children gain an understanding that someone can hold a mistaken (false) belief about the world. This ability occurs around four years of age (Callaghan et al., 2005; Wellman, Cross, & Watson, 2001) and is shown by children's performance in false belief tasks (Baron-Cohen, Leslie, & Frith, 1985; Wimmer & Perner, 1983). A standard false belief task typically involves a character (e.g., Sally) leaving an object (e.g., ball) in one location and whilst away another character (e.g., Anne) unexpectedly moving the object to a new location. When Sally returns the child is asked a direct question "Where will Sally look for her ball first?" A child that has a theory of mind will understand that

Sally will go to the location where she left the ball (because they understand this is where she thinks it is), rather than the second location (where they know the ball actually is). When children pass these tasks they now clearly show that they can *think* how someone *thinks about* something – in other words to understand different perspectives (Perner, 1991; Perner, Stummer, Sprung, & Doherty, 2002). This ability is metacognitive in nature as it involves being able to think about thinking (Flavell, Green, & Flavell, 2000).

5.1.1 Linking theory of mind and reading comprehension

By the time children begin to read at around five years old they will have acquired an understanding that mental states and perspectives may differ from reality, thus are able to begin to understand that in the text the writer will present intended meanings that may or may not represent the child's own perspective and knowledge (Lecce, Zocchi, Pagnin, Palladino, & Taumoepeau, 2010). They are able to apply understanding and reasoning about the minds of others to interpret the intentions of the author and the thoughts and actions of story characters. In support of this, Pelletier and Astington (2004) investigated the relationship between the developing theory-of-mind abilities of four and five year olds and their understanding of characters' actions and consciousness in story narratives. They found that children's ability to understand stories followed a similar developmental pathway as theory of mind. More specifically, children with an advanced theory of mind (as shown by their performance on theory-of-mind tasks and also their use of mental state terms such as "think" and "know") were more likely to have a coherent understanding of the story (over and above their general

language ability). Pelletier and Astington (2004) suggested that children's ability to understand and coordinate action and consciousness within a narrative is therefore clearly linked with their theory of mind.

Evidence linking theory of mind to reading comprehension, specifically, has recently been found in a study of adolescents with autism spectrum disorders (ASD) (Ricketts, Jones, Happé, & Charman, 2013). The authors found that theory-of-mind ability uniquely predicted reading comprehension over and above oral language skills and word reading ability. When considering these findings in light of the SVR, and consistent with Kirby and Savage (2008), they suggested the framework may need to be extended to include the contribution of social cognition, especially theory of mind, when accounting for reading comprehension in ASD.

Reading comprehension involves more than story narratives about characters set in the social world. It involves monitoring one's own knowledge (self-monitoring) whilst reading, but also responding to and adjusting to (repairing) other information that may be non-social or non-fictional in nature (Kirby & Savage, 2008). In other words, text may also represent and inform knowledge, actions and understandings, not necessarily to do with story characters or oneself as a reader. Importantly, theory of mind, as measured by false belief understanding, has been linked to other aspects of metacognition beyond social understanding, for example, it is linked to knowledge about memory and what makes remembering easier and more difficult, i.e., meta-memory (Lecce, Bianco, Demicheli, & Cavallini, 2014; Lockl & Schneider, 2007); to understanding that objects can have multiple names

or labels, i.e., metalinguistic ability (Perner et al., 2002) and also to children's understanding about the source of their knowledge (Bright-Paul, Jarrold, & Wright, 2008; O'Neill & Gopnik, 1991). It is unclear whether this link is due to theory of mind being a socially specialized ability that leads to or facilitates these more general or non-social metacognitive abilities (Lockl & Schneider, 2007; Ricketts et al., 2013) or whether theory of mind draws on the same underlying ability as these other aspects of metacognition (Iao, Leekam, Perner, & McConachie, 2011; Perner, 1991; Perner, Mauer, & Hildenbrand, 2011). Therefore, theory of mind might be expected to be linked to reading comprehension not only because of the social aspect of reading comprehension (i.e., understanding story character intentions, actions and behaviours), but also because of its links to other aspects of metacognition which may facilitate or contribute to the metacognitive requirements of reading comprehension more generally, i.e., comprehension monitoring (Kirby & Savage, 2008).

To date, there have been no longitudinal studies looking at the contribution of theory of mind to reading comprehension in typically developing children. A study by Lecce et al. (2010) reported a causal link from school-aged children's cognitive mental state knowledge to their later meta-knowledge about reading. They showed that, at nine and ten years old, early mental state knowledge (including false belief understanding) predicted subsequent meta-knowledge, which supports the view that children's understanding of mental states is a prerequisite for the development of their metacognitive abilities (Bartsch & Estes, 1996; Perner, 1991); however there was no direct test of children's actual reading comprehension ability.

5.1.2 Shared correlates of theory of mind and reading comprehension

The current study aimed to investigate whether theory of mind uniquely contributed to later reading comprehension ability over and above the dimensions of the SVR in a typically developing sample of young children. To fully determine the degree to which theory of mind may predict reading comprehension, it was also essential to consider factors that may potentially be shared by both skills. Therefore, it was necessary to identify and control for those cognitive factors that have repeatedly been linked to both reading and theory of mind: executive function and language ability.

5.1.2.1 Executive function and theory of mind

Children's executive function ability increases rapidly between three and four years old, and it is strongly linked to theory of mind development (Carlson & Moses, 2001; Carlson, Moses, & Breton, 2002; Devine & Hughes, 2014; Farrant, Mayberry, & Fletcher, 2012). There is still a debate as to whether executive functions help with the demonstration of theory-of-mind ability (expression) or contribute more directly to the conceptual understanding (emergence)(see Apperly, Samson, & Humphreys, 2009; Doherty, 2009 for reviews). Although research has clearly demonstrated close links between the two abilities, it is clear that theory of mind is more than an extension of executive functioning (Carlson & Moses, 2001). Results from a study of three and four year olds found that children's performance in a battery of theory-of-mind tasks were strongly inter-correlated, even after controlling for age, verbal ability and executive function ability. Executive function, particularly working memory, has also been shown to

be important for reading comprehension, not only through contribution to higher-order comprehension skills, such as inference making, comprehension monitoring and story structure knowledge, (Cain, Oakhill, & Bryant, 2004a; Sesma, Mahone, Levine, Eason, & Cutting, 2009), but also through its contribution to emergent code-related skills (Blair & Razza, 2007; Welsh, Nix, Blair, Bierman, & Nelson, 2010). Given the importance of executive function for both theory of mind and reading comprehension ability, executive function ability was controlled for in the regression analyses.

5.1.2.2 Language and theory of mind

As has been shown, the contribution of oral language skills to reading comprehension has been established through a wealth of research (e.g., Kendeou, van den Broek, White, & Lynch, 2009b; Gough & Tunmer, 1986; Paris & Paris, 2003; Vellutino, Tunmer, Jaccard, & Chen, 2007; see 1.4.1.2. for detailed review). Language development also plays a crucial role in the development of theory of mind. Though there is some evidence for theory of mind being important for later language ability (Slade & Ruffman, 2005), the stronger effect is for language promoting later theory of mind (Milligan, Astington, & Dack, 2007). Mental states are unobservable and language is necessary to verbally express the concepts (Ruffman, Slade, Rowlandson, Rumsey, & Garnham, 2003). Furthermore, there is consistent evidence to suggest that general language ability, rather than specific aspects of language (e.g., syntax or semantics), is most important for false belief understanding (Milligan et al., 2007; Ruffman et al., 2003; Slade & Ruffman, 2005). Given the importance of general language ability for both theory of mind and

reading comprehension ability, general language ability was also controlled for in the regression analyses.

5.1.3 The current study

The main aim of this current longitudinal study was to investigate the unique contribution of early theory-of-mind ability in preschool children to their later emergent reading comprehension at the end of Year 1. Current research has proposed that the two dimensions of word decoding and linguistic comprehension in the Simple View of Reading (Gough & Tunmer, 1986; Hoover & Gough, 1990) should be expanded to more fully to explain the complexities of reading comprehension (Kirby & Savage, 2008). This study proposed that theory of mind would contribute to reading comprehension skills over and above the two dimensions of the SVR (word decoding and linguistic comprehension skills). Furthermore, since research has shown theory-of-mind ability is clearly linked to executive function and language, this study will consider the longitudinal relationship between theory-of-mind ability, measured at two time points (Nursery and Reception), and later reading comprehension skills at the end of Year 1, after controlling for these abilities. Additionally, theory of mind was re-assessed at the end Year 1 to investigate the concurrent relationship between theory of mind and reading comprehension, to determine whether the relationship between theory of mind and reading comprehension was stable.

To investigate whether early and concurrent theory-of-mind ability was a unique predictor of performance in reading comprehension, it was necessary to use a

range of different, age-appropriate theory-of-mind tasks and account for other factors that potentially underpin both skills. As well as executive function and language skills, age and non-verbal ability were measured. Reading comprehension was assessed at the final time point at the end of Year 1, when the children were six years old. Additionally, in order to further investigate the contribution of theory of mind in light of the SVR (Gough & Tunmer, 1986; Hoover & Gough, 1990), reading efficiency and linguistic comprehension were also measured at this time point, as measures of the two dimensions of the SVR.

In conclusion, metacognition has been proposed as an important additional factor above the two dimensions of the SVR in reading comprehension. The current study aimed to investigate this using theory of mind as an early measure of metacognition by seeing whether it would uniquely predict reading comprehension over and above shared correlates of age, language and executive function and, also, over and above the two dimensions of the SVR.

5.2 Method

5.2.1 Participants

The initial sample at Time 1 comprised of 98 preschool children (51 boys and 47 girls; mean age = 3:10 years, SD = 3.5 months) attending the nursery year of two mainstream primary schools in South East England (refer to Chapter 2 for more details). At Time 2, in the reception year, 84 children (43 boys and 41 girls; mean age = 4:10 years, SD = 3.8 months) were available for retesting. At Time 3, the final testing session, at the end of Year 1, 80 children (41 boys and 39 girls) were

available for re-testing (mean age = 6:03 years, SD = 3.8 months). The current study includes data from the 80 children with complete data sets.

5.2.2 Materials & Measures

Brief descriptions of materials and measures for each time point are given below.

For further, more comprehensive details of the materials and scripts for administration please refer to Chapter 2.

5.2.2.1 Time 1 (Nursery)

5.2.2.1.1 Theory of Mind

Two first-order false belief tasks were used as a measure of children's theory-of-mind ability: unexpected contents and unexpected location.

The *unexpected contents task* involved the child being introduced to a story character who then remained out of sight while the child was asked to guess the contents of a 'Smarties®' tube. After the child had guessed, they were shown that the tube, unexpectedly, contained colouring pencils. The pencils were then returned to the tube and the child was asked the first test question, which required them to say what they had thought would be in the tube when they first saw it. The story character was re-introduced and the child was reminded that the character had not seen the contents of the tube. The second test question required the child to say what the story character would think was in the tube. The child was awarded one point for each correct answer and a further point for justifying their

answer to the second test question, if they had answered correctly, to give a maximum score of 3.

The *unexpected location task* required the child to watch a story, demonstrated by the researcher with 'Playmobil®' figures, where one character (Sally) played with a ball and then placed it inside a blue box. Sally then left the scene and a second figure (Anthony) came to play. Anthony found the ball, played with it and then placed it in the red box. Anthony left the scene and Sally returned wanting to play with ball once more. On Sally's return, the child was asked the test question, which required the child to state where Sally will look for the ball. One point was awarded for a correct answer (blue, where Sally thinks it is) and a further point awarded for an appropriate justification, if the test question had been answered correctly, to give a maximum score of 2.

5.2.2.1.2 Nonverbal ability

The Block Design subtest of The Wechsler Preschool and Primary Scale of Intelligence – III (WPPSI-III) (Wechsler, 2002) was used to measure the children's non-verbal ability. The maximum score was 19.

5.2.2.1.3 Oral language skills

The children's receptive vocabulary was assessed using the British Picture Vocabulary Scale: 2nd Edition (Dunn, Dunn, Whetton, & Burley, 1997). The maximum score was 84. Receptive and expressive language ability was measured through two subtests (linguistic concepts and recalling sentences in context) of the

Clinical Evaluation of Language Fundamentals – Preschool Second Edition (CELF-Preschool-2; Wiig, Secord, & Semel, 2004). The maximum scores were 20 and 52 respectively.

5.2.2.1.4 Executive function

5.2.2.1.4.1 *Working memory*

Two tasks were used to assess children's working memory ability: one word based and one digit based. The Reverse Word Span task (Slade & Ruffman, 2005) required children to reverse sets of two and three words orally presented by the researcher. The Cat and Mouse Working Memory Task (based on previous research by Keenan, 1998) consisted of a series of counting cards each showing coloured illustrations of a number of cats and twice the number of mice (ranging from 1 cat/2 mice to 6 cats/12 mice). Children were required to count, retain and then recall numbers from a series of two or three cards. Maximum score was 9 for the Reverse Word Span task and 30 for the Cat and Mouse task.

5.2.2.1.4.2 *Cognitive inhibition*

The Day-Night inhibition task (Carlson & Moses, 2001) was used to assess children's cognitive inhibition. The task required children to inhibit a verbal response to a visual stimulus. Children were shown pictures of a sun, to represent day, and a moon to represent night. To provoke an inhibitory response, the child was then required to respond 'night' when shown the picture of the sun, and to respond 'day' when shown the picture of the moon. The test items consist of 16

trials. One point was scored for providing the inhibitory response for each item giving a maximum score of 16.

5.2.2.1.4.3 Cognitive flexibility

A card-sorting task, adapted from Kloo and Perner's (2003) Dimensional Card Sorting task, was used to assess the children's cognitive flexibility. This task required the child to switch their response following a change of game rules. Initially, children were asked to sort a set of 9 cards (3 x yellow horse, 3 x red fish and 3 x blue bird) based on the colour of the illustrations. The test phase required the child to shift from their colour-based response to an animal-based response, as they were asked to sort another identical set of cards based on the type of animal illustrated on the card. One point was scored for each card correctly sorted in the 'animal' condition giving a maximum score of 9.

5.2.2.2 Time 2 (Reception)

5.2.2.2.1 Theory of Mind

Two second-order false belief tasks were used to assess the children's theory of mind: one belief-desire reasoning task and one unexpected location second-order false belief task.

The *belief-desire reasoning task* (Harris, Johnson, Hutton, Andrews, & Cooke, 1989) involved a story where one character played a 'nasty' surprise on another character. The researcher told the story using soft toys and props. The story involved two friends and, while one was away from the scene, the other replaced

the contents of a cola can with milk. The first friend returned and was thirsty, and saw the cola can. At this point, the child was asked the belief-desire test question, which asked them to say whether the friend was happy or sad when he saw the cola can. Subsequently, they were asked to justify their answer and asked a further first-order false belief question, which asked them to say what the friend thought was in the can. Throughout the story, the child was asked a series of four emotion contingency questions and a reality question about the actual contents of the can to ensure they understood the story. One point was awarded for the belief-desire question, if all the emotion contingency and reality questions had been correctly answered. A further point was awarded for an appropriate justification of the answer and a final point for the false belief question, if the reality question was answered correctly, to give a maximum score of 3.

The *unexpected location second-order false belief task* (Perner & Wimmer, 1985) involved a story told by the researcher using a series of four picture cards to accompany the narrative. The story showed two siblings placing a shared chocolate bar in the fridge. The brother returned and moved the chocolate to his bag, but, unbeknown to him, his sister watched him through the window. During the story, the child was asked two control questions to ensure they were following the complex storyline. At the end of the story, the child was asked the second-order false belief test question, which asked them to say where the brother thought the sister would look for the chocolate. They were then asked to justify their answer. Finally, the child was asked two further control questions relating to the original and current location of the chocolate. One point was awarded for the second-order false belief test question, if the final two control questions were

answered correct. A further point was given for the justification, if the test question was correct, to give a maximum score of 2.

5.2.2.2.2 Oral language skills

The Definitional Vocabulary Subtest of the Test of Preschool Early Literacy Skills (TOPEL; Lonigan, Wagner, Torgesen, & Rashotte, 2007) was used to gain a measure of the breadth and depth of the children's vocabulary knowledge. There were 35 items, with a potential score of 2 for each item (one for naming the item and one for a related question) giving a maximum score of 70.

Narrative recall was assessed using the Renfrew Bus Story Test 4th edition (Renfrew & Hancox, 1997). Children listened to a story, told by the researchers, with accompanying illustrations. Immediately following the narrative, children were asked to retell the story using the same illustrations. Children's narrative recall was recorded, transcribed and scored using the information subtest of the Bus Story Test. The scores reflected two aspects of the child's recall of the story: knowledge of content and order of narrative. The maximum score was 52.

5.2.2.2.3 Executive function

5.2.2.2.3.1 *Working memory*

The reverse word span task (Slade & Ruffman, 2005) was re-administered to assess children's working memory. The maximum score was 9.

5.2.2.2.3.2 Cognitive inhibition

Two tasks were used to assess the children's inhibitory control. *Luria's hand game* (Hughes, 1998; Luria, Pribam, & Homshaya, 1964) is a test of inhibition. Children initially imitated the researcher's hand movements (make a fist or point a finger). Subsequently, the rules changed for the test trials and the child was required to make the opposite movement from the researcher. There were 15 test trials. The child was awarded one point for each correct trial (maximum 15 points). "*Wack-A-Mole*" (Stimuli courtesy of Sarah Getz and the Sackler Institute for Developmental Psychobiology) is a computerized task using the go/ no go paradigm. Children 'played' the game over four two minute trials. During each trial, they were required press the spacebar when they saw a mole appear from a hole in the garden, but refrain from reacting if a vegetable appeared. The score for the task was the mean accuracy of the 'No Go' trials.

5.2.2.3 Time 3 (End Year 1)

5.2.2.3.1 Theory of Mind

An adaptation of Happé's strange stories (Happé, 1994; O'Hare et al., 2009) was used to assess the children's theory of mind. The child listened to a series of six short stories presented on a computer, with accompanying illustrations, using a Microsoft PowerPoint slideshow. Each story included one of six mentalising concepts: sarcasm, belief-based misunderstanding, contrary emotions, faux pas or double bluff. After each story the child was asked a test question requiring a yes/no response. The child was then asked to justify their answer. Some of the stories included further control questions. The order of presentation of the stories

was counterbalanced and each child watched one of four different orders. Coding for the justification answer was based on a scoring rubric (O'Hare et al., 2009) with scores ranging from 0 -2. The response for each question was allocated to one of four categories: incorrect, physical state, partial psychological state or psychological state full and accurate answer. The first two categories were both considered incorrect, as the question did not ask about physical events or outcomes, and both received no points. The psychological categories received one point for a partial answer and two points for a full and accurate answer.

In contrast, to O'Hare et al. (2009) the scores were adjusted in consideration of the comprehension control question, where points for the mentalising question were awarded only if the control question(s) was correct. The unadjusted and adjusted scores for the Strange Stories task were highly correlated ($r = .9$), but it was considered that using the adjusted scores was more consistent with the theory of mind measures at earlier time points. The maximum score was 12.

5.2.2.3.2 Oral language skills

The British Picture Vocabulary Scale: 2nd Edition (Dunn et al., 1997) was re-administered to assess the children's receptive vocabulary. Children's narrative recall and comprehension ability was assessed using a task based on the work of Paris & Paris (2003). Children were asked to tell the story from a wordless picture storybook. Once the book was completed, and removed, children were asked to recall the story. Children's recall was recorded, transcribed and scored for content

(six aspects of the narrative: characters, setting, initiating event, problem, solution, and ending) and awareness of story structure, giving a maximum score of 9.

Following recall, the book was replaced in front of the child and the researcher asked a set of ten comprehension questions, turning to the corresponding page of the book before asking each question. Children's responses were transcribed in full and marked using a scoring rubric that awarded 0 to 2 points for each question, giving a maximum score of 20 points. An overall narrative comprehension score was calculated by summing the recall and comprehension scores to give a maximum total of 29. For further details of administration and scoring see section 2.5.4.3.2.

5.2.2.3.3 Executive function

5.2.2.3.3.1 *Working memory*

Children completed two working memory tasks to assess the processing and storage of digits and words (Cain et al., 2004a). The digit working memory task required children to read aloud groups of three digits and remember the last digit from each group in the same order as presentation for later recall. The sentence-span task involved children listening to groups of short sentences with the final word missing. Children were required to finish the sentence and remember their words for later recall, once again in the same order as presentation. One point was awarded for every correct digit/word that was recalled in its correct location, giving a maximum score of 27 for each task.

5.2.2.3.3.2 *Cognitive inhibition*

A task using the Stroop paradigm (based on a previous study by Prevor & Diamond, 2005) was developed to assess cognitive inhibition: the colour/object switch task. The task consisted of three timed tests. The first required children to name colours on a page of 20 coloured line drawings of squares (4 x 5 colours). The second required them to name 20 line drawings of objects (4 x 5 object types) shown in their congruent colours, e.g., pink pig, blue whale. In the third test, children were shown another 20 line drawings of the same objects, but this time the drawings used incongruent colours, and children were asked to name the colours. Before each test, the child was told that the aim was to name the items as fast as possible. The interference score (measured in seconds) was calculated by subtracting the predicted score (mean time of test 1 and test 2) from the time of test 3.

5.2.2.3.4 Reading comprehension

The York Assessment of Reading for Comprehension: Passage Reading (YARC; Snowling et al., 2011) was used to assess children's comprehension skills. The standardised test comprised of graded passages, alternating between fiction and non-fiction, for reading aloud by children aged five to 11 years. Children were required to read two passages. Following each passage, children were asked a set of eight comprehension questions tapping literal and inferential comprehension skills.

In preparation for the YARC, children completed the Single Word Reading Test (SWRT; Foster, 2007). This test consisted of six graded sets of ten words of

increased difficulty. The raw score from the SWRT determined the starting passage level for the YARC. Children then completed two consecutive passages from the YARC. Children were timed as they read the passages aloud, with the exception of the beginner's passage. The accuracy of their reading was recorded for all passages. Standard scores were calculated for comprehension skills, accuracy of reading and, when possible, reading rate; however only the comprehension score is used in the analysis in this study. In light of the SVR, reading efficiency was measured as word, rather than passage reading, and an alternative test was used (see below).

5.2.2.3.5 Reading efficiency

The Test of Word Reading Efficiency (TOWRE; Rashotte, Torgesen, & Wagner, 1999) was used to measure children's word reading accuracy and fluency. The TOWRE is standardised for children from the age of six years and consists of two subtests involving word and non-word stimuli to provide measures of sight word reading efficiency and decoding efficiency, respectively. Data from the subtests are combined to provide an overall reading efficiency score. Although there was some concern about the sensitivity of the TOWRE for a young population, standard scores from the TOWRE compared favourably with other concurrent indicators of reading ability. Strong correlations were found between the TOWRE and measures from the Single Word Reading Test, YARC passage reading accuracy and YARC passage reading rate ($r = .86, .83, .89$ respectively).

5.2.3 Procedure

Informed (opt-in) consent was obtained from schools and informed (opt-out) consent from the parents for children to participate in the longitudinal study. The children were initially tested (T1) during the second term in their nursery year. The children were tested individually in a quiet area immediately outside of their classroom. Each child completed four 15 to 20 minute sessions (mean assessment period = 21.32 days, SD = 7.17). These initial testing sessions were part of a wider study, and aimed to establish baseline measures for the children and covered an extensive range of cognitive measures. Tasks were divided between the four testing sessions to provide a range and variety of activities within each session to maintain children's attention and reduce fatigue. Administration of the test sessions was fully counterbalanced both within the session itself and in the order with which the children completed the sessions.

Children were reassessed, one year later, at the beginning of the second term of the reception year (T2). Once again, children were tested individually in a quiet area close to their classrooms. Each child completed two 20-minute assessment sessions (mean assessment period = 6 days, SD = 4.25). Test sessions were counterbalanced, as were the tasks within the sessions, with the exception of the theory-of-mind tasks that were completed in the same order; the belief-desire reasoning task followed by the second-order false belief task, as this is developmentally appropriate.

In Year 1, children were tested at the end of the summer term (T3). As before, children were tested individually in a quiet area outside of their classrooms. At

Time 3, children completed three 20-minute sessions (mean assessment period = 11 days, SD = 7.09).

5.3 Results

5.3.1 Descriptive statistics

Descriptive statistics for all variables are presented in Table 5.1. Distributions for most variables were acceptable, with the exception of measures of cognitive inhibition at each time point. Distribution statistics revealed a negative skew for the Day/ Night task at T1 and for Luria's hand game at T2, suggesting that scores were close to ceiling. At T3, the distribution of the Colour-Object-Switch task showed a positive skew, suggesting that the task lacked sensitivity and the majority of the sample showed low interference scores. Previous analyses in this study investigating cognitive precursors of reading comprehension (see Chapter 3) excluded all cognitive inhibition measures as they failed to significantly correlate with Year 1 reading comprehension. However, research has consistently reported links between theory of mind and executive function (EF) abilities, including inhibition and working memory; therefore it was considered important to control for both aspects of executive function in these analyses. Logarithm transformations were performed to address variables with a positive skew and a reflection and logarithm transformation was applied to those variables with a negative skew. Data resulting from the Colour-Object-Switch task was reflected for ease of interpretation. The transformed variables were used in the analyses.

Table 5.1: Means and standard deviations for ToM and cognitive variables at T1, T2 and T3

	<i>N</i>	Maximum	Mean (<i>SD</i>)	Range
T1 (Nursery – spring term)				
<i>Non verbal ability</i>				
Block design	80	19	12.09 (3.05)	4-18
<i>Language</i>				
Receptive vocabulary (BPVS)	80	84	47.19 (10.27)	23-71
CELF recall sentence	80	52	34.12 (10.08)	2-52
CELF linguistic concepts	80	20	14.29 (4.00)	1-20
<i>Executive function</i>				
Reverse word span WM task	80	9	2.19 (2.53)	0-8
Cat & mouse WM task	80	30	5.99 (5.41)	0-20
Day/night task	80	16	11.63 (4.50)	0-16
Card sorting	80	9	5.43 (3.59)	0-9
<i>Theory of mind</i>				
False belief tasks	80	5	2.26 (1.90)	0-5
T2 (Reception – spring term)				
<i>Oral Language</i>				
Definitional Vocabulary (TOPEL)	80	70	55.24 (6.16)	43-67
Narrative comprehension (Bus story)	80	52	19.05 (7.38)	5-35
<i>Executive function</i>				
Reverse word span WM task	80	15	4.69 (2.60)	0-10
Luria's hand game	80	15	14 (1.57)	7-15
Wack-a-mole (seconds)	80	-	.78 (.14)	.31-1.00
<i>Theory of mind</i>				
2nd order belief tasks	78	5	2.38 (1.62)	0-5
T3 (Year 1 – end of year)				
<i>Oral Language</i>				
Receptive vocabulary (BPVS)	80	120	74.71 (11.64)	45-102
Narrative comprehension	80	29	18.01 (4.52)	9-27
<i>Executive function</i>				
Sentence span WM task	80	27	9.99 (3.16)	0-15
WM digit task	80	27	8.16 (3.11)	1-15
Colour Object Switch (secs)	79	-	9.43 (6.47)	-.61-29.68
<i>Theory of mind</i>				
Strange stories	80	10	3.68 (2.31)	0-9
<i>Decoding</i>				
Reading Efficiency (TOWRE)	80	SS	123.56 (15.86)	90-154
<i>Reading comprehension</i>				
YARC	80	SS	108.03 (9.17)	81-125

Note: All raw scores unless otherwise noted; SS = standard scores; ToM = theory of mind; BPVS = British Picture Vocabulary Scale; CELF = Clinical Evaluation of Language Fundamentals; WM = working memory; TOPEL = Test of Preschool Early Literacy; TOWRE = Test of Word Reading Efficiency; ; YARC = York Assessment of Reading for Comprehension

Descriptive statistics at individual task level are reported in Table 5.1; however, composite scores for the language measures were used in the subsequent analyses. These scores were calculated to give a richer measure of language ability (see 4.3.2.3 for more details). The composite score at each time point included a measure of vocabulary and also included measures of expressive and

receptive language at T1 and of narrative comprehension at T2 and T3. Further composite scores were calculated for theory of mind and executive function.

Details are reported below.

5.3.2 Composite scores

5.3.2.1 Theory of mind

Children completed two false belief tasks at T1 and two second-order tasks at T2. At each time point, the two concurrent tasks were significantly correlated (T1: $r = .48, p < .01$; T2: $r = .26, p = .02$). The scores for the two tasks were summed to give composite theory of mind scores for each time point. At T3, children completed the Strange Stories task; the adjusted mean scores (range 0 – 2) for each of the six stories are reported in Table 2. The story involving sarcasm was close to floor and it was excluded. The adjusted scores from the other five stories were summed to give a composite score.

Table 5.2:
Means and standard deviations for Strange Stories Task at T3

	Maximum	Time 3	
		Mean	SD
Display	2	1.2	.80
Contrary emotion	2	.79	.87
Misunderstanding	2	.65	.90
Faux pas	2	.65	.94
Double bluff	2	.36	.69
Sarcasm	2	.03	.22

5.3.2.2 Executive function

The means and standard deviations for the various executive function (EF) tasks are shown in Table 5.1. Zero-order correlations between EF measures at the

three time points are shown in Table 5.3. Significant correlations were found between all working memory measures, both concurrently and longitudinally. Correlations between the inhibition measures were all positive, albeit less consistent and weaker than those between working memory measures, which may indicate that the EF measures were less sensitive and reliable than the WM measures.

Table 5.3:

Zero-order correlations between executive function measures at T1, T2 and T3

	1	2	3	4	5	6	7	8	9
<i>Nursery (T1)</i>									
1. WM reverse word span	-								
2. WM cat & mouse	.36**	-							
3. CI day/night	.29*	.17	-						
4. CF card sort	.27*	.28*	.14	-					
<i>Reception (T2)</i>									
5. WM reverse word span	.52**	.28*	.28*	.21	-				
6. CI Luria hand game	.32**	.13	.07	.21	.31**	-			
7. CI Wack-a-mole	.02	.17	.12	.15	.12	.16	-		
<i>Year 1 (T3)</i>									
8. WM sentence span	.41**	.35**	.07	.38**	.33**	.14	.25*	-	
9. WM digit task	.35**	.38**	.10	.28*	.41**	.23*	.03	.33**	-
10. CI colour object	.15	.30**	.15	.14	.24*	.28*	.07	.13	.11

*Notes: * $p < .05$; ** $p < .01$; T1 = Time 1; T2 = Time 2; T3 = Time 3; WM = working memory; CI = cognitive inhibition; CF = cognitive flexibility*

In order to obtain a richer measure of executive function, it was decided that all tasks would be used to form a composite measure for each time point. At T1, scores for the two working memory tasks, day/night task and card sorting task were standardized and summed to form T1 EF composite. At T2, the working memory task and both inhibition tasks were standardized and summed to give a T2 EF composite score. Finally, at T3, both working memory tasks and the colour

object switch task were standardized and summed for the T3 EF composite. Zero-order correlations between the three composite measures were acceptable and all significant (T1 and T2, $r = .43$; T1 and T3, $r = .36$; T2 and T3, $r = .45$, all $ps < .01$).

5.3.3 Correlation analyses

Zero-order concurrent and longitudinal correlations between key composite measures across the three time points are reported in Table 5.4.

Table 5.4:

Zero-order correlations between ToM and key composite measures at T1, T2 and T3

	1	2	3	4	5	6	7	8	9	10	11	12
1. Age	-											
Nursery (T1)												
2. NVA	-.02	-										
3. Language	.48**	.37**	-									
4. EF	.46**	.23*	.51**	-								
5. ToM	.21	.29*	.61**	.41**	-							
Reception (T2)												
6. Language	.44**	.32*	.76**	.53**	.49**	-						
7. EF	.23*	.24*	.35**	.43**	.17	.39**	-					
8. ToM	.40**	.23*	.60**	.38**	.49**	.58**	.38**	-				
End Year 1												
9. Language	.43**	.33**	.71**	.52**	.54**	.72**	.37**	.54*	-			
10. EF	.18	.35**	.29*	.36**	.14	.28*	.45**	.09	.25*	-		
11. ToM	.29**	.18	.49**	.33**	.51**	.44**	.16	.28*	.43**	.13	-	
12. Word read.	-.13	.38**	.18	.17	.18	.26*	.48**	.28*	.18	.39**	.06	-
13. Read. comp	-.09	.36**	.36**	.32**	.44**	.42**	.33**	.33**	.43**	.26*	.23*	.54**

Notes: * $p < .05$; ** $p < .01$; T1 = Time 1; T2 = Time 2; T3 = Time 3; NVA = non-verbal ability; Language = composite of language skills; EF = executive function; ToM = theory of mind; Word read = word reading efficiency (words and non-words); Read comp = reading comprehension

5.3.3.1 Concurrent relationships

Concurrent measures of language and theory of mind significantly correlated at each time points ($rs = .61$, $.58$ and $.43$, all $ps < .01$). Executive function (EF) also

significantly correlated with concurrent theory of mind at T1 and T2 ($r_s = .41$ and $.38$, $ps < .01$), but was non-significant at T3. Concurrent language and EF were significantly correlated at each time point ($r_s = .51$, $.39$ and $.25$, *all ps* $< .05$). At T3, as expected from the SVR model, reading efficiency and linguistic comprehension were significantly related to reading comprehension. Additionally at T3, concurrent measures of EF and theory of mind were also significantly correlated with reading comprehension.

5.3.3.2 Longitudinal relationships

Theory of mind at each time point significantly correlated with T3 reading comprehension, although the relationship became weaker from T1 through to the concurrent measure at T3 ($r_s = .44$, $.33$ and $.23$, *all ps* $< .05$). Language measures at all time points significantly correlated with T3 theory of mind. For EF measures, only T1 EF measure significantly correlated with T3 theory of mind. The longitudinal relationship between T2 EF and later theory of mind at T3 was non-significant.

T1 theory of mind was strongly correlated with T3 linguistic comprehension ($r = .53$, $p < .001$); however, its relationship with word reading efficiency was non-significant, suggesting that when considering reading comprehension in light of the SVR dimensions, the relationship between early theory of mind and reading comprehension may be via linguistic comprehension but not through word reading ability.

5.3.4 Regression analyses

To investigate the longitudinal effects of theory of mind on later reading comprehension, a series of hierarchical regression analyses were performed to determine if the addition of early measures of theory of mind improved the prediction of end of Year 1 reading comprehension beyond that accounted for by differences in non-verbal ability, language skills and executive function. To account for age in the analyses, all variables were residualised for age (see 2.6 for rationale), with the exception of variables with standard scores (T1 non-verbal ability, T3 reading efficiency and T3 reading comprehension). Analysis was performed using SPSS REGRESSION and SPSS EXPLORE for evaluation of assumptions.

Three analyses were conducted to investigate the unique contribution of theory of mind at each time point to later reading comprehension at T3. In each of the three analyses, reading comprehension at T3 was the criterion variable. At Step 1 of each analysis, non-verbal ability⁶, language composite and EF skills were entered and the concurrent theory of mind measure was entered at Step 2. Following each step in the analyses, residuals and influence statistics were explored to check and address any violation of assumptions of normality. Where a significant skew was found in the distribution of standardized residuals, further investigation was conducted to identify multivariate outliers. The outcome for each regression is reported below.

⁶ Non-verbal ability was measured only at Time 1. This measure was used in all analyses to control for non-verbal ability.

5.3.4.1 Nursery (T1) theory of mind to T3 reading comprehension

Hierarchical regression analysis ($n = 80$) was carried out to investigate the degree to which preschool theory of mind (T1) accounted for unique variance in reading comprehension at the end of Year 1 (T3). Initial exploration of the results showed a significantly negative skew in distribution of the standardized residuals.

Investigation revealed one participant with a standardized residual < -3 . Further investigation showed unacceptably high values for Mahalanobis distance and leverage values. The participant was identified as a multivariate outlier and was excluded from the data set. The regression analysis was re-run with a sample size of 79. Exploration of the standardized residuals showed a normal distribution.

Individual standardized residuals showed one further case with a standardized residual outside the -2.5 to 2.5 range. As this represented less than 5% of participants, it was deemed acceptable (Field, 2009). Results of this analysis are reported in Table 5.5.

Step 1 of the analysis produced a significant model, $F(3, 75) = 9.19, p = < .001$ and an R^2 value of .27. Examination of the coefficients showed that T1 non-verbal ability, language skills and EF all uniquely predicted significant variance in reading comprehension at the end of Year 1 (T3).

Table 5.5: *Hierarchical regression model: T1 ToM and control variables predicting T3 reading comprehension*

Variable	ΔR^2	$B (SE B)$	β	p
Outcome variable: Year 1 (T3) reading comprehension ($N = 80$)				
<i>Step 1</i>	.27*			
Nonverbal ability		0.65 (.32)	.23	.049*
T1 language skills		1.36 (.57)	.28	.019*
T1 EF		1.08 (.51)	.23	.039*
<i>Step 2</i>	.08*			
Nonverbal ability		0.65 (.31)	.23	.038*
T1 language skills		0.14 (.66)	.03	.833
T1 EF		0.78 (.50)	.17	.119
T1 ToM (False belief)		3.20 (1.08)	.36	.004*
Total $R^2 = .35^*$; $F(4, 74) = 9.80, p < .001$				

Notes: T1 = Time 1; T3 = Time 3; EF = executive function; ToM = theory of mind

With the addition of T1 ToM at Step 2, an improved model was constructed, $F(4, 74) = 9.80, p < .001$. A significant change in R^2 of .08 suggested that T1 theory of mind accounted for 8% of unique variance in reading comprehension ability at the end of Year 1. Further examination of the coefficients following Step 2 showed that non-verbal ability remained a significant predictor of T3 reading comprehension; however, both language skills and EF ability did not make any further unique contribution to T3 reading comprehension, suggesting covariance with theory of mind.

5.3.4.2 Reception (T2) theory of mind to T3 reading comprehension

A second hierarchical regression analysis was carried out to determine whether theory of mind, measured one year later, at T2, continued to make a unique contribution to later reading comprehension at the end of Year 1 (T3). Two participants had not completed theory of mind measures at this time point, due to

researcher error, and were therefore excluded from the regression analysis. Data for the remaining 78 participants were entered into the regression analysis. Initial exploration of the results showed a significant negative skew in the distribution of the standardized residuals. Investigation of residual and influence statistics revealed three participants with standardized residual values of less than -2.5 and one participant with unacceptably high values for Mahalanobis distance and leverage values. Data from these participants were excluded and the regression was repeated, with a sample size of 74. The resulting data showed a normal distribution of standardized residuals. The results of the analysis are reported in Table 5.6.

Table 5.6:
Hierarchical regression model: T2 ToM & control variables predicting T3 reading comprehension

Variable	ΔR^2	<i>B</i> (<i>SE B</i>)	β	<i>p</i>
Outcome variable: Year 1 (T3) reading comprehension (<i>N</i> = 74)				
<i>Step 1</i>	.42*			
Nonverbal ability		0.26 (.26)	.10	.325
T2 language comprehension		2.46 (.48)	.53	< .001*
T2 EF		0.60 (.37)	.16	.115
<i>Step 2</i>	.03*			
Nonverbal ability		0.23 (.25)	.09	.379
T2 language comprehension		2.01 (.51)	.44	< .001*
T2 EF		0.45 (.37)	.12	.236
T2 ToM (2 nd order belief tasks)		1.69 (.81)	.22	.042*
Total R^2 = .45*; $F(4, 69) = 14.30, p < .001$				

Notes: T2 = Time 2; T3 = Time 3; EF = executive function; ToM = theory of mind

The model produced by Step 1 was significant, $F(3, 70) = 16.84, p < .001$. The R^2 value suggested that, overall, T2 language and EF skills, along with non-verbal ability, accounted for 42% of variance in T3 reading comprehension. Examination

of the coefficients showed that T2 language comprehension was the only significant unique predictor of T3 reading comprehension. Inspection of the semi-partial correlations produced by the regression revealed that T2 language comprehension accounted for 22% of unique variance in reading comprehension. Non-verbal ability and T2 EF did not make significant unique contribution to T3 reading comprehension; however, semi-partial correlations showed that in combination with T2 language comprehension, they accounted for a further 20% of shared variance.

Step 2 improved the model, $F(4, 69) = 14.30, p < .001$ and T2 theory of mind accounted for a further small, but significant 3% of the variance in T3 reading comprehension.

5.3.4.3 Year 1 (T3) theory of mind to concurrent reading comprehension

A third hierarchical regression model was constructed to evaluate the degree to which concurrent theory of mind uniquely contributed to T3 reading comprehension. One participant had not completed the cognitive inhibition task at T3, due to colour-blindness, and was excluded from the analysis. Data for the remaining 79 participants were entered into the regression analysis. Initial exploration of the standardized residuals showed a significantly negative skew. Examination of residual and influence statistics showed three cases with standardized residuals outside the -2.5 to 2.5 range. Data for these participants were excluded and the analysis was rerun with a sample size of 76. The resulting

data showed a normal distribution of the standardized residuals. Results are reported in Table 5.7.

Table 5.7:
Hierarchical regression model: T3 ToM & control variables predicting T3 reading comprehension

Variable	ΔR^2	<i>B</i> (<i>SE B</i>)	β	<i>p</i>
Outcome variable: Year 1 (T3) reading comprehension (<i>N</i> = 76)				
<i>Step 1</i>	.37*			
Nonverbal ability		0.11 (.28)	.04	.688
T3 linguistic comprehension		2.71 (.50)	.54	< .001*
T3 EF		0.29 (.17)	.16	.102
<i>Step 2</i>	.01			
Nonverbal ability		0.23 (.25)	.03	.749
T3 linguistic comprehension		2.01 (.51)	.52	< .001*
T3 EF		0.45 (.37)	.18	.080
T3 ToM (Strange stories)		0.65 (.80)	.08	.416
Total R^2 = .38*; $F(4, 71) = 10.76, p < .001$				

Notes: T3 = Time 3; EF = executive function; ToM = theory of mind

Step 1 of the analysis produced a significant model, $F(3, 72) = 14.19, p < .001$ and an R^2 value of .37 suggested that T3 linguistic comprehension, T3 EF and non-verbal ability together accounted for more than a third of variance in T3 reading comprehension. Inspection of the coefficients revealed that T3 linguistic comprehension was the only significant unique predictor of T3 reading comprehension. Investigation of the semi-partial correlations derived from the regression revealed that T3 linguistic comprehension accounted for 25% of unique variance in T3 reading comprehension.

At Step 2, the model was significant, $F(4, 71) = 10.76, p < .001$ and the addition of T3 theory of mind resulted in a small, non-significant change in R^2 . At Step 2, T3

linguistic comprehension remained the only significant unique predictor of T3 reading comprehension.

5.3.4.4 Does T1 theory of mind uniquely predict T3 reading comprehension over and above the dimensions of the SVR?

Further analysis was conducted to investigate if early preschool (T1) theory of mind significantly predicted T3 reading comprehension, at the end of Year 1, over and above the two dimensions (word reading and linguistic comprehension) proposed by the SVR. A hierarchical regression analysis was conducted to investigate the relationship between T1 theory of mind and T3 reading comprehension after controlling for T3 reading efficiency (TOWRE) and T3 linguistic comprehension. Past research has established a significant relationship between theory of mind and EF; therefore T3 EF was also entered as a further control variable.

At Step 1, T3 reading efficiency, T3 linguistic comprehension and T3 EF were entered. Initial exploration of the results showed a normal distribution of the standardized residuals; however, investigation of residual and influence statistics revealed one case with unacceptably high values for Mahalanobis distance and leverage values. Data from this participant was excluded. The participant with missing EF inhibition data was also excluded, leaving a sample size of 78. The regression analysis was rerun. At Step 2, T1 theory of mind was entered. The resulting data showed a normal distribution of standardized residuals. The results of the analysis are reported in Table 5.8.

Table 5.8:

Hierarchical regression model: T1 ToM predicting T3 reading comprehension controlling for T3 SVR dimensions

Variable	ΔR^2	<i>B</i> (<i>SE B</i>)	β	<i>p</i>
Outcome variable: Year 1 (T3) reading comprehension (<i>N</i> = 78)				
<i>Step 1</i>	.44*			
T3 reading efficiency		0.23 (.05)	.41	< .001*
T3 linguistic comprehension		2.35 (.53)	.41	< .001*
T3 EF		0.30 (.60)	.05	.624
<i>Step 2</i>	.05*			
T3 reading efficiency		0.22 (.05)	.38	.001*
T3 linguistic comprehension		1.45 (.61)	.25	.019*
T3 EF		0.37 (.58)	.06	.529
T1 ToM (False belief)		2.44 (.91)	.28	.009*
Total R^2 = .49*; $F(4, 73) = 17.62, p < .001$				

Notes: T1 = Time 1; T3 = Time 3; EF = executive function; ToM = theory of mind

Step 1 of the analysis produced a significant model, $F(3, 74) = 19.45, p < .001$ and an R^2 value of .44. Examination of the coefficients showed that both T3 reading efficiency and T3 linguistic comprehension were significant unique predictors of T3 reading comprehension. Investigation of the semi-partial correlations produced by the regression revealed that T3 reading efficiency accounted for 14% of unique variance in reading comprehension and T3 linguistic comprehension explained a further 15% of unique variance. EF was not a significant predictor of T3 reading comprehension; however, the semi-partial correlations showed that in combination with reading efficiency and language comprehension, a further 15% of shared variance was explained.

Entering T1 theory of mind at Step 2 resulted in a further significant model, $F(4, 73) = 17.62, p < .001$. Evaluation of the coefficients showed that reading efficiency and linguistic comprehension remained significant predictors of T3 reading

comprehension, and T1 theory of mind accounted for a further, significant 5% of unique variability in T3 reading comprehension. The results suggested that early theory of mind remained a significant unique predictor to reading comprehension over and above the dimensions of the SVR.

5.4 Discussion

The main aim of the current study was to investigate the longitudinal relationship between early theory-of-mind ability in preschool children and their later emergent reading comprehension at the end of Year 1. Children completed a battery of theory of mind assessments, including false belief tasks during their second term at preschool nursery (T1), second-order belief tasks a year later in Reception (T2) and finally, Happé's strange stories (Happé, 1994; O'Hare et al., 2009) at the end of the Year 1 (T3).

Correlation analysis and a series of hierarchical regressions were conducted to examine the longitudinal relationships between theory of mind at each of the first two time points and reading comprehension at the end of Year 1. At the end of Year 1 (T3), the concurrent relationship between theory of mind and reading comprehension was also explored. In consideration of the strong links with both theory of mind and reading comprehension, language and executive function skills were also measured at each time point and their effects controlled within the analyses.

5.4.1 Does theory of mind predict ability in reading comprehension?

Results suggested that early preschool theory of mind at three to four years old, measured through false belief tasks, uniquely contributed to reading comprehension ability more than two years later at six years old. This early measure of theory of mind significantly accounted for 8% of unique variance in later reading comprehension (T3), after controlling for age and preschool (T1) measures of non-verbal ability, executive function and language skills. In Reception (T2), theory of mind, measured using second-order belief tasks, also significantly contributed to later reading comprehension, although the relationship was weaker, accounting for smaller, but significant, 3% of variance. The concurrent predictive relationship between theory of mind and reading comprehension at the end of Year 1 (T3) did not reach significance, although there was a significant correlation between the two variables suggesting a degree of shared variance. In sum, *early* theory of mind uniquely predicted later reading comprehension. As such, these data are consistent with data that found early theory of mind relates to later cognitive performance (Lecce et al., 2014; Lockl & Schneider, 2007), but, specifically, in this study to reading comprehension.

A further question of this study was whether early theory of mind, as an index of metacognitive ability, would predict later reading comprehension over and above the two dimension of the SVR: word reading and linguistic comprehension.

Correlational analyses had shown that there was no significant relationship between theory of mind at T1 and word reading efficiency at T3, therefore the predictive relationship from theory of mind to reading comprehension was not expected to be through the word reading dimension. However, considering the

robust correlations between theory of mind and language (Milligan et al., 2007), it was considered possible that the relationship between theory of mind and reading comprehension might operate via the linguistic comprehension dimension of the SVR (measured by receptive vocabulary and narrative comprehension) at T3.

At the end of Year 1 (T3), as expected, both word reading efficiency and linguistic comprehension significantly accounted for unique variance in reading comprehension. In combination with concurrent executive function ability, the two factors accounted for 44% of variance in reading comprehension, although, interestingly, executive function did not account for any significant unique variance. Preschool (T1) theory of mind, however, did account for unique variance in reading comprehension over and above word reading efficiency, linguistic comprehension and executive function. This finding provided evidence that early theory of mind, as an index of metacognitive ability, might be an important component to include in the SVR model (Kirby & Savage, 2008). This is a novel finding and may be an important contribution to the understanding of the development of reading comprehension.

Different theory-of-mind measures were used for each academic year to avoid the ceiling effects of false belief tasks. The range of ability within each of the tasks was consistent with performances of other children of similar ages in previous research (Hughes et al., 2000; O'Hare et al., 2009). At three to four years old, half the children in the current study passed the first-order tasks, with 30% also justifying their answer. At four to five years old, 58% of the children passed the

second-order false belief task and 75% passed the false belief-desire reasoning task. Performance in the Strange Stories task was low, but consistent with the performance of five and six year olds in previous studies (O'Hare et al., 2009). The tasks at all time points were significantly inter-correlated, supporting both stability of individual differences in theory-of-mind ability (Hughes, Ensor, & Marks, 2010) and good test-retest reliability (Hughes et al., 2000; Hutchins, Prelock, & Chace, 2008), suggesting that all tasks were tapping the same construct.

The trend representing the decreasing effect of theory-of-mind ability on later reading comprehension may be due to the different measurement methods; however, the stability of individual differences and reliability of the tasks suggest that this may not be the case. Alternatively, the increasing contribution of language skills to later reading comprehension may suggest more shared variance between concurrent language ability and theory of mind tasks resulting in reduced levels of unique contribution from theory-of-mind ability. However, this account is not supported by correlation analysis, which reports marginally stronger concurrent correlations between language and first-order and second-order theory-of-mind tasks than with the later Strange Stories task. A further explanation of the decreasing trend may be that the predictive value of theory of mind to later reading comprehension is as a result of *when* children gain a theory of mind rather than an ongoing contribution. If skills underpinning theory of mind are shared by reading comprehension, it may be that once children gain a theory of mind, it leads to a 'watershed' in the availability for those skills and thus the direct effect decreases over the time points as more children have already

gained a theory of mind. Alternatively, gaining theory of mind early may provide children with longer exposure to and, therefore, greater experience of using metacognitive abilities.

5.4.2 Why does early theory of mind predict reading comprehension?

A wealth of research has reported that children typically begin to pass false belief tasks between the ages of three and five years old (Callaghan et al., 2005; Wellman, Cross, & Watson, 2001). Importantly, evidence has been found linking performance in false belief tasks and other metacognitive tasks (Lecce et al., 2014; Lecce et al., 2010; Lockl & Schneider, 2007; Perner, et al., 2002).

Specifically, Lockl and Schneider (2007) concluded from their study that those children acquiring an *early* theory of mind performed better in the later meta-memory tasks, suggesting that gaining a theory of mind might be a crucial step in metacognitive development. It seems reasonable to extend this theory to a relationship between false belief understanding and reading comprehension. Successful reading comprehension requires the application of metacognition (Kirby & Savage, 2008). Text related skills such as self-monitoring, the use of repair strategies and awareness and use of structure require the use of metacognitive skills. Indeed, Lecce et al. (2010) reported a causal link from school-aged children's cognitive mental state knowledge to their later meta-knowledge about reading. Early false belief understanding indexes metacognitive abilities, and early availability of these metacognitive resources might lead to enhanced performance in later reading comprehension. Consistent with this view, results of the current study have shown that children's ability to pass explicit

false belief tasks at this time uniquely contributed to their reading comprehension ability almost two and half years later, over and above non-verbal ability, language skills and executive function ability.

5.4.3 Theory of mind and SVR account of reading comprehension

The Simple View of Reading (SVR) proposes that reading comprehension is the product of word reading skills and linguistic comprehension. More recently, researchers have suggested that the SVR is too simple and additional factors may need to be considered (Kirby & Savage, 2008). This study found that preschool theory of mind at three years uniquely contributed to Year 1 reading comprehension at six years over and above the dimensions of the SVR. However, it is worth noting that there was some reduction in the unique variance explained by theory of mind after controlling for the linguistic component. It is therefore possible that theory of mind may also have an indirect effect on reading comprehension by promoting linguistic comprehension. Indeed, false belief understanding has been shown to improve mental state inference making for narrative story characters in listening comprehension tasks (Pelletier & Astington, 2004). Whilst the relationship between early theory of mind and later linguistic comprehension was not tested, it is consistent with studies that show that theory of mind may have some influence on later language development (Milligan et al., 2007; Slade & Ruffman, 2005). However, a predictive relationship remained between early theory of mind and overall reading comprehension, over and above the linguistic comprehension dimension of the SVR. To reiterate, this

suggests that preschool theory of mind is predicting abilities specific to reading comprehension that go beyond skills required to comprehend spoken language. Recent research within a sample of adolescents with autism spectrum disorders (ASD) found that performance on Happé's Strange Stories task and the Frith-Happé animations (nonverbal stimuli for assessing social cognition) both uniquely contributed to their reading comprehension ability, beyond language skills and word reading ability (Ricketts et al., 2013). The authors propose that one account for this relationship may be that theory of mind acts as a "gate-keeper" to facilitate the necessary skills for inference making to create a 'situation model' where global knowledge and experience are integrated with the mental representation of the text (Perfetti, Landi, & Oakhill, 2005). This is consistent with the view of theory of mind as a socially specialized ability (He, Bolz & Baillargeon, 2011; Leslie, 2005; Luo & Baillargeon, 2010; Onishi & Baillargeon, 2005; Scott, 2014) that may facilitate more general metacognitive abilities. The results of the current study may be consistent with this account. Within a typically developing population, children demonstrate false belief understanding during the preschool years and it may facilitate the later development of different aspects of metacognition, including the metacognitive strategies required for reading comprehension. However, an alternative explanation may be that gaining false belief understanding is a crucial step reflecting the availability of domain general metacognitive ability (Iao et al., 2011; Perner, 1991; Perner et al., 2011), such that *early* theory of mind allows children greater exposure and opportunities to use metacognitive strategies. One benefit of early metacognition may be early development of higher order comprehension skills (e.g., self

monitoring and repair strategies), which promote increased performance in reading comprehension.

As a result of their study, Ricketts et al. (2013) suggest that the SVR framework should be extended to include mental state understanding when accounting for reading comprehension in an ASD population. The results from the current study also support the view that theory of mind is a significant predictor of reading comprehension in *typically developing children*, and therefore should be included in the SVR model. The results from this study support the view that an account of metacognition is essential to provide a full explanation of reading comprehension (Kirby & Savage, 2008). The SVR may need to be expanded to account for metacognitive skills, particularly for the acquisition and early development of reading comprehension.

5.4.4 Limitations

One of the main strengths of the current longitudinal study was initially assessing pre-readers before the beginning of formal literacy instruction; however research with very young children brings inherent problems of reliable measures.

Identifying age appropriate tasks is challenging, and in general, a battery of tasks, over several assessment sessions, measuring each construct is more reliable than single measures alone (Shepard, Kagan, & Wurtz, 1998). Theory of mind was measured in the Nursery using two false belief tasks: unexpected location and unexpected contents; however a more extensive battery of tasks may have more accurately measured individual differences in ability. Additionally, in Reception

and Year 1, to avoid ceiling effects, theory of mind was assessed with second-order belief tasks and Happé's strange stories respectively. These assessments are considerably more complex than first-order explicit false belief tasks and may place heavy demands on language skills and working memory to understand the storylines (Doherty, 2009). The shared variance of the variables may have led to an underrepresentation of the relationship between reading comprehension and theory of mind at the later time points. It is also possible that the broader measure of Strange Stories may not be tapping metacognitive ability in the same way as explicit false belief tasks.

The results of the study showing a predictive relationship from early theory of mind to reading comprehension are argued to reflect the idea that theory of mind indexes metacognitive ability. To explore this view further, it is crucial to take other aspects of metacognitive ability into account (for example, measures of source monitoring; Bright-Paul, Jarrold, & Wright, 2008; O'Neill & Gopnik, 1991). The current study did not include additional measures of metacognition. Future research in this field should address this issue and assess concurrent metacognitive ability at each time point. Additionally, reading comprehension at six years is highly correlated with word reading ability and, although the current study has suggested that language skills are equally important even at this early stage, the relationship with theory of mind may change once word reading has become more fluent and efficient. Follow up assessments of reading comprehension are vital to investigate the potential changes in these relationships.

5.4.5 Conclusion and Implications

In conclusion, this study has extended research in early reading comprehension by providing evidence that a novel factor, theory of mind, contributed to performance of reading comprehension, over and above age, non-verbal ability, language and executive function, in a typically developing population. Specifically, it highlighted that gaining early theory of mind (measured by false belief understanding) predicted better reading comprehension ability, more than two years later. Theory of mind is considered to be an index of metacognitive ability and the current study supports previous research that has argued that early theory of mind leads to better performance in later metacognitive tasks (Lecce et al., 2014; Lockl & Schneider, 2007). This study has shown that early ability predicts later reading comprehension performance. Children may benefit from early theory of mind because it allows earlier and greater experience of applying metacognitive strategies, which become crucial for reading comprehension.

Additionally, the results of this study contribute to the debate regarding the oversimplicity of the Simple View of Reading. Researchers have suggested that the SVR should be extended to account for metacognitive strategies that are essential for effective reading comprehension (Kirby and Savage, 2008). This study found that early theory of mind predicted later reading comprehension over and above the dimensions of the SVR: word reading ability and linguistic comprehension. Theory of mind, assessed through false belief understanding, indexes metacognition, therefore, the results appear to support the view that metacognitive ability should be an additional component of the SVR.

Robust relationships between language and executive function for both theory of mind (Devine & Hughes, 2014; Milligan et al., 2007) and reading comprehension (Cain et al., 2004a; Kendeou et al., 2009b; Paris & Paris, 2003; Sesma et al., 2009) have been well established. As a result, instruction and training in these skills are being increasingly promoted through the early years of education (Diamond, Barnett, Thomas, & Munro, 2007). The predictive link between theory of mind and reading comprehension, over and above the effects of language and executive function, suggest that theory of mind may be an additional crucial step in the development of reading comprehension. As a measure of metacognition, it may add benefits in cognitive performance beyond social cognition. Therefore, instruction and training in areas (such as false belief tasks) which have recently begun to be explored (Lecce et al., 2014), may be beneficial in leading to enhanced performance in other skills requiring metacognitive input.

An abundance of research has reported the contribution of preschool social and environmental factors to the development of theory of mind, such as, SES (Cutting & Dunn, 1999), mothers' mental state talk (Hughes et al., 2010; Ruffman Slade, & Crowe, 2002) and sibling relationships (McAlister & Peterson, 2006, 2013; Perner, Ruffman, & Leekam, 1994). Additionally, this thesis has reported the role of preschool social and environmental influences in the development of reading comprehension (see Chapter 3). Specifically, the current research found indirect links between the home literacy environment and later reading comprehension via early language skills and letter knowledge. Further research is needed to integrate these two fields of research. The factors supporting the development of theory of mind may also indirectly support the acquisition of reading

comprehension beyond the development of language and executive function skills. For example, promoting the use of mother's mental state talk within the home literacy environment may be an important step in helping to prepare children for school. Gaining a theory of mind provides an understanding of the minds of others, helping children to navigate the social world, which is crucial in the school environment. However, it appears that an early theory of mind may have wider benefits. It may help to facilitate the development of general metacognitive abilities or it may be an index of the availability of metacognition; either way it could be a relatively simple method of testing children's early metacognitive ability, which in turn may provide a useful early marker in the acquisition of reading comprehension.

Chapter 6 Early profiles of unexpected poor and unexpected good comprehenders

6.1 Introduction

The Simple View of Reading (SVR; Gough & Tunmer, 1986; Hoover & Tunmer, 1990) proposes that children need to be competent at two sets of skills to become proficient readers. Firstly, they need to efficiently recognise the form and meaning of words from print and, secondly, use semantic information at word level to develop sentence and discourse comprehension. The SVR describes these two skill sets as word recognition and linguistic comprehension. As discussed in previous chapters, although these skill sets correlate, they are separable and their development is underpinned by different cognitive abilities (e.g., Kendeou, van den Broek, White, & Lynch, 2009b; Oakhill, Cain, & Bryant, 2003; Storch & Whitehurst, 2002). The development of word reading is supported by code-related skills (e.g., letter knowledge, print knowledge and phonological awareness) and linguistic comprehension by oral language skill (e.g., vocabulary and listening comprehension) (Kendeou et al., 2009b; Storch & Whitehurst, 2002). According to the SVR, reading comprehension is the *product* of word recognition and linguistic comprehension; therefore it follows that if reading difficulties develop it will be as a result of deficits in word recognition, language comprehension or a combination of both (Cain & Oakhill, 2007; Catts, Hogan, & Fey, 2003).

Children showing deficits in both skills sets are labeled 'garden-variety' poor readers (Cain & Oakhill, 2007; Catts, Hogan, & Fey, 2003), as they often also

perform poorly on general cognitive tests, such that their reading comprehension problems are part of a more general deficit. More recently, researchers have referred to this subgroup of poor readers as having *language-learning disabilities (LLD)* to reflect their language deficits (Catts et al., 2003). Children who typically perform well on IQ tasks, but have problems in the area of word recognition in the absence of language deficits, are often referred to as having *dyslexia* (Bishop & Snowling, 2004). In contrast, the final subgroup, *poor comprehenders*, primarily has problems with language comprehension, but relatively good word recognition skills. Despite being able to read age-appropriate text with sufficient accuracy and fluency these children have difficulty understanding what they have read (Cain & Oakhill, 2006, 2007; Catts et al., 2003; Nation, 2005b). In a group of 183 seven-year-old *poor readers*, Catts et al. (2003) identified 36% to have poor word reading and poor listening comprehension, 36% to have word reading difficulties with adequate listening comprehension and 15% to have adequate word reading with poor listening comprehension skills. In typically developing populations, research has suggested that approximately 10% of children show the ‘poor comprehender’ reading profile (Nation, 2005b).

6.1.1 Poor comprehenders

Research has shown that poor comprehenders read superficially and engage less in higher order comprehension processing (inference making and comprehension monitoring) than their peers (Cain, Oakhill, Barnes, & Bryant, 2001; Oakhill & Yuill, 1996). Additionally, associations with weaknesses in oral language (e.g., receptive and expressive vocabulary, synonym judgment, and semantic fluency)

have been highlighted in several studies (e.g., Cain et al., 2001; Nation, Clarke, Marshall & Durand, 2004; Nation, Snowling, & Clarke, 2007). However, poor comprehenders have been shown to perform well on phonological processing and phonological awareness tasks (Cain, Oakhill, & Bryant, 2000). Nation and colleagues (Nation et al., 2004) propose that competence in phonological processing enable poor comprehenders to develop good decoding and word recognition skills, while weaknesses in non-phonological aspects of language, e.g., vocabulary, limit their comprehension. See section 1.3.4 for further discussion of poor comprehenders.

Early reading comprehension is initially limited by word recognition skills. Children cannot demonstrate comprehension of written text until they master an adequate degree of accuracy and fluency in word reading skills. Therefore, typically, in existing literature children's reading comprehension problems have not been highlighted until eight years and upward (Nation, 2005b). By this time, children may already be experiencing consequences of poor comprehension. It is, therefore, important to highlight cognitive deficits underpinning comprehension problems at an earlier stage, allowing for the introduction of targeted interventions and strategies before children begin to struggle with their reading (Nation, Cocksey, Taylor, & Bishop, 2010). More recently, researchers have taken a novel approach, aiming to identify early impairments, by retrospectively examining the cognitive profiles of children who have been identified as poor comprehenders in adolescence or later childhood (Catts, Adlof, & Weismer, 2006; Nation et al., 2010).

Catts et al. (2006) identified 57 poor comprehenders at 13 years (Grade 8) and compared concurrent and retrospective cognitive abilities with a group of 27 children categorized as poor decoders (poor word recognition with normal reading comprehension) and 98 typical readers. They found that the poor comprehenders showed concurrent weaknesses in vocabulary and grammatical understanding, consistent with the profiles of younger poor comprehenders (Nation et al., 2004). Examination of retrospective data revealed that the poor comprehenders had consistently scored below typical readers and poor decoders on a language composite measure in Kindergarten, Grade 2 and Grade 4. Supporting previous research, Catts et al. (2006) found that the poor comprehenders did not differ from typical readers in phonological processing in the later grades; however they found that the poor comprehenders had shown a deficit in phonological awareness in kindergarten. The authors suggested that the lower score might have resulted from other language deficits, perhaps vocabulary which may influence performance in phonological tasks, as poor ability at this early stage did not impact on later development where poor comprehenders' performance in phonological awareness was similar to typical readers.

Nation et al. (2010) conducted a similar study with younger children. They followed the progress of 172 children from five to eight years, identifying, at aged eight, 15 children (8.7% of the sample) as poor comprehenders and comparing their profiles to 15 age-matched control children. The control children were matched with poor comprehenders for reading accuracy. Consistent with previous research they found that poor comprehenders demonstrated mild-to-moderate language weaknesses both concurrently and retrospectively from the

age of five. In contrast to Catts et al. (2006), the poor comprehenders in Nation et al. (2010) showed normal phonological processing skills throughout the study, with scores indistinguishable from the control children, even at five years of age. The poor comprehender group also demonstrated normal levels of letter knowledge at five years and they established word-reading skills at the same rate as the control children. Their reading fluency, for both words and non-words, was typical throughout the study.

In addition to specific word reading and language skills, Nation et al. (2010) also measured children's reading comprehension at six, seven and eight years. Results found that those children who were later identified as poor comprehenders at eight years scored less than the control children at each time point. Over the two years, the control children showed improvements in their raw scores; however, the poor comprehenders showed minimal growth in raw scores, suggesting that reading comprehension impairments remained relatively stable through the mid primary years. The implication of this evidence is that it may be feasible to identify poor comprehenders at six years, enabling targeted intervention through the earliest stages of reading comprehension development. The children in the current study completed a reading comprehension task at six years old and it was the aim of the study to investigate children's earlier cognitive abilities relative to their performance at that time.

Previous studies have identified poor comprehenders directly from their scores on reading comprehension and word reading tasks. Catts et al. (2006) identified poor comprehenders as participants who scored below the 25th percentile in

reading comprehension and above the 40th percentile in word recognition. Nation et al. (2010) identified children as poor comprehenders if they achieved a reading accuracy standard score above 90 and a reading comprehension score below 90 (additionally, there had to be at least 10 standard score points between both scores). Both studies excluded non-verbal ability from the selection procedure, as both studies found poor comprehenders achieved lower non-verbal ability scores than typical readers. However, Catts et al. (2006) conducted secondary analyses with non-verbal ability as a covariate and reported that the pattern of results was essentially the same as when non-verbal ability was not controlled; they therefore suggest that non-verbal ability is not an influential factor in poor comprehension.

In an earlier study, Nation, Clarke and Snowling (2002) investigated the general cognitive ability of children with comprehension difficulties. They found that overall, poor comprehenders had lower cognitive ability than control children matched for chronological age and word reading ability; however, they were still of average ability and differences were largely accounted for by variation in verbal ability. In their study of seven to nine year-old poor comprehenders, Nation et al. (2002) also examined the relationship between general cognitive ability and component reading skills to determine whether children had poor comprehension skills relative to those anticipated from IQ scores, or whether their reading skills were stronger than would be expected from their IQ. The results suggested that both profiles existed. The majority of poor comprehenders had average general ability and showed lower than expected comprehension scores. However, there was a small minority (2%) with lower general cognitive

ability that had comprehension levels predicted by their general cognitive scores, but showed advance reading ability.

6.1.2 Identifying poor comprehenders

The matching design has been useful in identifying children with a discrepancy between their word reading and reading comprehension abilities; however, concerns have been raised regarding this method of identifying poor comprehenders (Tong, Deacon, Kirby, Cain, & Parrila, 2011). Typically, in matching studies, children's word reading abilities have been measured in context (e.g., Cain, 2006) or through non-word reading scores (e.g., Nation & Snowling, 1999). Tong et al. (2011) argue that the former fails to account for skilled comprehenders making more effective use of the context than poor comprehenders, resulting in their ability to read more words accurately. They also argue that the latter only accounts for the reading of regular words, therefore matched groups may still differ on irregular words. Additionally, they suggest that fluency of word reading also plays a key role in word reading efficiency (e.g., Klaua & Guthrie, 2008) and should be considered along with non-verbal ability (Tong et al., 2011).

Recent studies have introduced a novel approach to investigating the cognitive profiles underlying reading comprehension difficulties by identifying and comparing three, rather than two, types of comprehenders: unexpected poor comprehenders, expected average comprehenders and unexpected good comprehenders (Li & Kirby, 2014; Tong et al., 2011). Tong et al. (2011) use the

term 'unexpected poor comprehenders' to reflect that the deficit in reading comprehension demonstrated by these children is relative to what would be predicted from their word reading skills and general ability. In these studies children were identified and categorized using a regression technique. Reading comprehension was predicted from age, non-verbal ability, word-reading accuracy and word-reading speed. Reading comprehension scores were then plotted against predicted scores. Children well below the regression line (below the lower 70% confidence interval) were identified as unexpected poor comprehenders, those well above (above the upper 70% confidence interval) as unexpected good comprehenders and those close (within 20% confidence intervals) to the regression line as expected average comprehenders.

Li and Kirby (2014) argue that the comparison of the three groups provides a better understanding of the profile of poor comprehenders than examining differences between poor comprehenders and a control group matched solely on word reading ability. They suggest that expected average comprehenders provide a more appropriate comparison group for poor comprehenders, because this comparison "examines relative as opposed to absolute discrepancies between skills" (Li & Kirby, 2014, p. 77). The regression technique provides a method of incorporating multiple factors (sight word reading, non-word reading, fluency and non-verbal ability) in the selection of groups, with the advantage of identifying three comparison groups. Matching studies have almost certainly included children in the control group who have performed better on reading comprehension tasks than would be expected from their word reading scores (Li & Kirby, 2014). Tong et al. (2011) argue that identifying those children as a

separate comparison group provides additional information that may be useful to understanding developmental trajectories underlying reading comprehension.

Tong et al. (2011) used the regression technique to investigate the sources of reading comprehension difficulties in Grade 5 (age 10 years) children. Li and Kirby (2014) examined reading comprehension difficulties in Grade 8 (aged 13 years) Chinese students learning English as a second language. However, to date, the regression technique has not been used to explore reading comprehension difficulties in very young UK readers. Indeed, as noted above, there is limited research examining the early profiles of poor comprehenders (Catts et al., 2006; Nation et al., 2010), and these studies have not examined the *preschool* profile of the children who have been later identified as poor comprehenders. The current longitudinal study aimed to use this regression technique to identify unexpected poor comprehenders, expected average comprehenders and unexpected good comprehenders in a sample of six year-old children. Retrospective data for each group was subsequently examined to determine between-group differences in children's preschool cognitive profiles. In light of previous finding from this research project that theory of mind (see Chapter 5) and preschool home literacy experiences (see Chapter 3) related to later reading comprehension performance, either directly or indirectly via the component dimensions of the SVR, these factors were included in the profile analyses.

6.1.3 The current study

In the current study, a sample of typically developing three to four year-old children ($M = 3:10$ years, $SD = 3.73$ months) were assessed during their Nursery year (T1). Children were all non-readers and were assessed the year before they began formal literacy instruction. Children completed an extensive range of cognitive assessments, including non-verbal ability, code related skills (letter knowledge, print knowledge and PA), oral language skills (receptive vocabulary and receptive and expressive language skills) and theory of mind. Additionally measures of the home literacy environment were collected via a parental report questionnaire. Children were reassessed at the end of Year 1 (T2), aged six ($M = 6:03$ years, $SD = 3.89$ months), in word reading efficiency (single word and non-word), oral language (receptive vocabulary and narrative comprehension), and theory of mind. At this time, children also completed a standardized reading comprehension task.

To my knowledge, this is the first study to investigate the preschool cognitive profile of six-year-old unexpected poor, average and good comprehenders. It adds to existing research in numerous ways. Firstly, it uses reading comprehension performance measured at six years to identify poor comprehenders, which is two years younger than typically reported in the literature. Secondly, it uses the regression technique to identify the three categories of reading comprehension ability and, in line with the regression technique, the current study accounts for non-verbal ability, single word reading, decoding (non-word reading) and reading fluency, when identifying comprehender groups. Thirdly, the current study extends existing knowledge by examining the retrospective preschool cognitive

profile of poor comprehenders at three years of age. Fourthly, it adds to existing knowledge through the examination of the profiles of children identified as average and good comprehenders. Finally, it investigates and compares differences between comprehender categories for two new factors, theory of mind and preschool HLE.

6.2 Method

6.2.1 Participants

The participants for this study were selected from a sample of 80 children (41 boys and 39 girls; mean age = 6:03 years, $SD = 3.8$ months) attending Year 1 of two mainstream primary schools in southeast England. Children had entered the schools at preschool, 'nursery' level and informed consent was obtained at that time from schools and parents (using an 'opt out' procedure at the request of the schools) for children to participate in the longitudinal study. Children completed a range of cognitive assessments during the second term of their nursery year (Time 1; mean age = 3:10 years, $SD = 3.7$ months), before they received any formal literacy instruction, providing retrospective preschool cognitive data for all 80 children. At nursery level, children attended five half-day classes per week. The following academic year (Reception), when children were aged four to five, they began full-time education and started formal literacy instruction. One year later, at the end of Year 1, children's reading comprehension was assessed, (T2; mean age = 6:03 years, $SD = 3.8$ months), following two years of literacy instruction.

Groups of unexpected poor comprehenders, expected average comprehenders and unexpected good comprehenders were identified from the sample using regression analysis. Following the procedure used in previous studies (Li & Kirby, 2014; Tong et al., 2011), children's reading comprehension scores were regressed on their non-verbal ability⁷ and word reading efficiency scores (single word and non-word reading accuracy and speed), accounting for 32% of the variance. All scores used in the regression analysis were standardized scores, thereby controlling for age. Children's actual reading comprehension scores were plotted against the standardized predicted values from the regression analysis (see Figure 6.1).

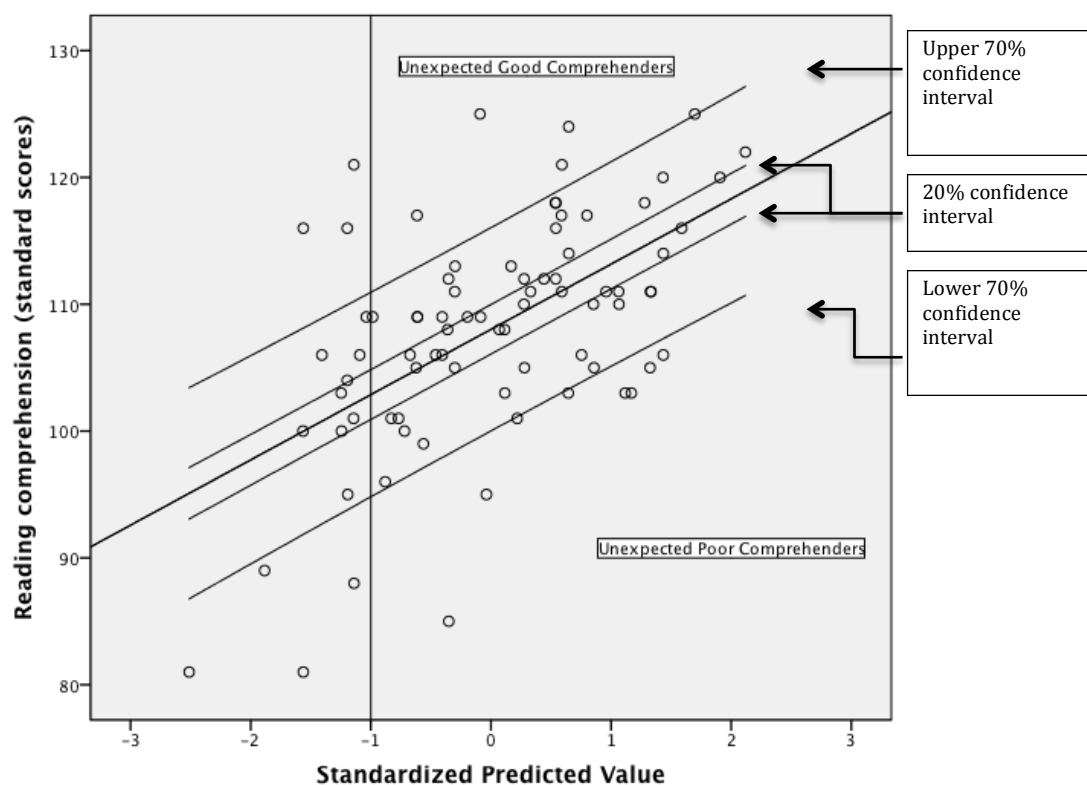


Figure 6.1: Scatterplot for the distribution of actual reading comprehension scores against predicted values from the regression predicting reading comprehension from non-verbal ability and word reading efficiency.

⁷ Non-verbal ability was measured at TI during initial assessments.

Initially, children whose predicted values were below 1 *SD* of the overall mean were excluded to remove those children whose low reading comprehension scores were consistent with their low predicted scores (following Li & Kirby, 2014; Tong et al., 2011). Confidence intervals around the regression line were then introduced to allow more precise definition of the three groups. Previous studies, although using the same regression method, have differed in their choice of confidence intervals. Tong et al. (2010) used 80% and 25%, and Li & Kirby (2014) used 70% and 20%. The current study selected 70% and 20% in order to define the groups more precisely and avoid having children on boundary levels. Children above the upper 70% confidence interval of the regression line were defined as unexpected good comprehenders and those below the lower 70% confidence interval were defined as poor comprehenders. Children who scored close to the regression line, within the 20% confidence intervals, were defined as expected average comprehenders (see Figure 6.1).

Six unexpected poor comprehenders (two boys and four girl) and five unexpected good comprehenders (three boys and two girls) were identified. Fifteen expected average comprehenders were identified, but, in accordance with Tong et al. (2011), only six of these children were included in the study to create relatively equal-sized groups. The expected average comprehenders (three boys and three girls) were matched with the other groups on gender, age, non-verbal ability and word efficiency (Tong et al., 2010).

Means and standard deviations for age, non-verbal ability, word-reading efficiency and reading comprehension are reported in Table 6.1. One-way

analysis of variance (ANOVA) results are also reported in Table 6.1. Results showed that there were no significant differences between the groups in age, non-verbal ability and word reading efficiency. As expected, there was a significant difference between the groups in reading comprehension.

Table 6.1:

Means, standard deviations, and ANOVA results for Unexpected Poor comprehenders, Expected Average Comprehenders, and Unexpected Good Comprehenders for age, non-verbal ability, word reading efficiency and reading comprehension

<i>Measure</i>	<i>Unexpected Poor Comprehenders^a</i>		<i>Expected Average Comprehenders^b</i>		<i>Unexpected Good Comprehenders^c</i>		<i>F(2,14)</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
Age	73.57	4.16	74.57	4.19	73.29	3.73	0.20
Non-verbal Ability	13.57	1.27	14.14	2.54	12.29	2.50	0.06
Word Read Efficiency	135.17	14.54	131.00	13.48	129.40	13.56	0.26
Reading Comprehension	99.50	8.09	111.67	5.16	122.40	3.44	19.87**

Notes: ^a *N* = 6, ^b *N* = 6, ^c *N* = 5; ***p* < .001

6.2.2 Materials & Measures

Brief descriptions of materials and measures for each time point are given below.

For further, more comprehensive details of the materials and scripts for administration refer to Chapter 2.

6.2.2.1 Time 1 (T1): Nursery (spring term)

6.2.2.1.1 Nonverbal ability

The Block Design subtest of The Wechsler Preschool and Primary Scale of Intelligence – III (WPPSI-III) (Wechsler, 2002) was used to measure children's

non-verbal ability. The maximum score was 19. Scores were used as a control measure in the regression analysis conducted to identify comprehender groups.

6.2.2.1.2 Letter knowledge

The Alphabet Knowledge subtest of the PAT (Muter, Hulme, & Snowling, 1997) was used to establish children's alphabet knowledge. Children were presented with each letter of the alphabet printed individually on a card, and asked to give the name and/or sound of the letter. The maximum score was 26.

6.2.2.1.3 Print knowledge

The Print Knowledge subtest of the Test of Preschool Early Literacy (TOPEL) (Lonigan, Wagner, Torgeson, & Rashotte, 2007) was used to measure children's print knowledge. The Print Knowledge subtest measures early knowledge about written language conventions and form. The maximum score was 12.

6.2.2.1.4 Phonological awareness

To assess children's phonological awareness (PA), two subtests of the Phonological Abilities Test (PAT; Muter et al., 1997) were used: rhyme detection and word completion. Scores for the two subtests were summed to give a maximum score of 26.

6.2.2.1.5 Receptive vocabulary

Children's receptive vocabulary was assessed using the British Picture Vocabulary Scale: 2nd Edition (Dunn, Dunn, Whetton, & Burley, 1997). The maximum score was 84.

6.2.2.1.6 Language skills

Language skills were measured through two subtests of the Clinical Evaluation of Language Fundamentals – Preschool Second Edition (CELF-Preschool-2; Wiig, Secord, & Semel, 2004). Linguistic Concepts assessed receptive language, giving a maximum score of 20. Recalling Sentences in Context measured expressive language and gave a maximum score of 52. Scores from both tests were summed to give an overall language skills score (maximum 72).

6.2.2.1.7 Working memory

Two tasks were used to assess children's working memory ability: one word based and one digit based. The Reverse Word Span task (Slade & Ruffman, 2005) required children to reverse sets of two and three words orally presented by the researcher (see section 2.5.1.6.1 for details). The Cat and Mouse Digit task (based on previous research by Keenan, 1998) required children to count, retain and then recall numbers from a series of two or three cards. Maximum score was 9 for the Reverse Word Span task and 30 for the Cat and Mouse task (see section 2.5.1.6.2 for details). Standard scores were calculated for both tasks and the mean calculated to give an overall working memory score.

6.2.2.1.8 Theory of mind

Two first-order false belief tasks were used to measure children's theory-of-mind ability: unexpected contents and unexpected location. See section 2.5.1.7 for details of tasks. Unexpected contents task gave a maximum of 3 points and unexpected location gave a maximum of 2 points. Scores for both tasks were summed to give an overall theory of mind score (maximum 5).

6.2.2.1.9 Home literacy environment (HLE)

Parents completed a HLE questionnaire reporting frequency of parent-child shared book reading, frequency of direct teaching of literacy skills (e.g., read words), frequency of their child asking to be read to and frequency of library visits. Additionally, to assess the quality of shared reading, parents were asked to report the frequency of their child's active engagement during storybook reading for six measures, e.g., point at letters/words. A further direct, child-administered measure of storybook exposure was also included in T1 assessments; the Title Recognition Task (TRT) required children to indicate (yes or no) whether they recognised titles of books (real book titles and foils) that were orally presented by the researcher.

Data from the questionnaire and TRT was used to compute four HLE composite scores: Storybook Exposure, Parental Teaching, Child Interest in Reading and Child Narrative Engagement. For details of measures refer to section 2.5.1.8.3. For details of computation of composite scores refer to section 3.3.3.

6.2.2.2 Time 2 (T2): Year 1 (end of summer term)

6.2.2.2.1 Reading efficiency

The Test of Word Reading Efficiency (TOWRE; Rashotte, Torgesen & Wagner, 1999) was used to measure children's word and non-word reading accuracy and fluency. The TOWRE is standardised from six years old and consists of two subtests to provide measures of sight word reading efficiency and decoding efficiency. Data from the subtests are combined to provide an overall reading efficiency score. The standardised scores were used as a control measure in the regression analysis conducted to identify comprehender groups.

6.2.2.2.2 Phonological awareness

Two subtests of the Comprehensive Test of Phonological Processing (CTOPP; Wagner, Torgesen, & Rashotte, 1999) were used to assess children's phonological processing: elision and blending words. Scores from the two tests were summed to give a maximum score of 40.

6.2.2.2.3 Receptive vocabulary

The British Picture Vocabulary Scale: 2nd Edition (Dunn et al., 1997) was re-administered to assess the children's receptive vocabulary. The maximum score was 120.

6.2.2.2.4 Narrative comprehension

Children's narrative recall and comprehension ability was assessed using a task based on the work of Paris and Paris (2003). Children were asked tell the story

from a wordless picture storybook. Once the book was completed, and removed, children were asked to recall the story. Children's recall was recorded and later transcribed and scored, giving a maximum score of 9. Following recall, the book was replaced in front of the child and the researcher asked a set of ten comprehension questions, turning to the corresponding page of the book before asking each question. Children's responses were transcribed in full and marked using a scoring rubric that awarded 0 to 2 points for each question, giving a maximum score of 20 points. An overall narrative comprehension score was calculated by summing the recall and comprehension scores to give a maximum total of 29. For further details of administration and scoring see section 2.5.4.3.2.

6.2.2.2.5 Working memory

Two tasks were used to assess children's working memory ability: one word based and one digit based, based on previous research (Cain, Oakhill, & Bryant, 2004a). The digit working memory task required children to read aloud groups of three digits and remember the last digit from each group in the same order as presentation for later recall. The sentence-span task involved children listening to groups of short sentences with the final word missing. Children were required to finish the sentence and remember their words for later recall, once again in the same order as presentation. Both tasks had a maximum score of 27. See section 2.5.4.5.1 for details of both tasks. Standard scores were calculated for both tasks and the mean calculated to give an overall working memory score.

6.2.2.2.6 Theory of mind

An adaptation of Happé's strange stories (Happé, 1994; O'Hare, Bremner, Nash, Happé, & Pettigrew, 2009) was used to assess the children's theory of mind.

Children listened to a series of six short stories and each story included one of six mentalising concepts: sarcasm, belief-based misunderstanding, contrary emotions, faux pas or double bluff. After each story children were asked a series of control question and test questions. Answers were transcribed in full and coded using a scoring rubric with scores for each question ranging from 0 -2, giving a maximum score of 12. See section 2.5.4.6 for administration and scoring procedures.

6.2.2.2.7 Reading comprehension

The York Assessment of Reading for Comprehension: Passage Reading (YARC; Snowling et al., 2011) was used to assess children's comprehension skills. The standardised test comprised of graded passages, alternating between fiction and non-fiction, for reading aloud by children aged five to 11 years. Children were required to read two passages. Following each passage, children were asked a set of eight comprehension questions tapping literal and inferential comprehension skills. Answers to comprehension questions were transcribed and scored according to test instructions. Standardized scores were computed and used in analyses.

6.2.3 Procedure

Informed (opt-in) consent was obtained from head teachers for schools to participate in the longitudinal study. Information about the study was sent home to parents, via classroom teachers. Parents were requested to 'opt out', if they did not want their child to participate in the study (see 2.3 for details). Parents were also sent the HLE questionnaire via classroom teachers.

6.2.3.1 Time 1 (T1)

Children were initially tested (T1) during the second term in their nursery year. Children were tested individually in a quiet area immediately outside of their classroom. Each child completed four 15 to 20 minute sessions (mean assessment period = 21 days, $SD = 7.17$). These initial testing sessions aimed to establish baseline measures for the children and covered an extensive range of cognitive measures. Tasks were divided between the four testing sessions to provide a range and variety of activities, within each session, to maintain children's attention and reduce fatigue. Administration of the test sessions was fully counterbalanced both within the session itself and in the order with which the children completed the sessions.

6.2.3.2 Time 2 (T2)

Children were reassessed, 28 months later, at the end of Year 1 (T2). As before, children were tested individually in a quiet area outside of their classrooms. At T2, children completed three 20-minute sessions (mean assessment period = 11

days, $SD = 7.09$). Test sessions were counterbalanced, as were the tasks within the sessions.

6.3 Results

6.3.1 Descriptive statistics

Data from the total sample ($n = 80$) were used to examine the distribution of all variables. Distributions for most variables were acceptable, however a significant positive skew was observed in T1 letter knowledge. A square root transformation (Tabachnick & Fidell, 2007) was performed to address the positive skew and the transformed score was used in the analyses. Means and standard deviations for T1 variables for each of three groups (unexpected poor comprehenders, expected average comprehenders and unexpected good comprehenders) are reported in Table 6.2 (cognitive variables) and Table 6.3 (home literacy variables). Means and standard deviations for T2 variables for the three groups are shown in Table 6.4.

6.3.2 Group differences on T1 cognitive variables

A multivariate analysis of variance (MANOVA) was conducted to test for retrospective differences between the three groups, identified at T2 as unexpected poor comprehenders, expected average comprehenders and unexpected good comprehenders, on preschool (T1) correlates of reading (letter knowledge, print knowledge, phonological awareness, receptive vocabulary, language skills, working memory and theory of mind).

Table 6.2:
Means, Standard Deviations, and ANOVA results for Unexpected Poor Comprehenders, Expected Average Comprehenders and Unexpected Good Comprehenders on T1 cognitive measures

Measure	UPC ^a		EAC ^b		UGC ^c		Pairwise Comparison ^d
	M	SD	M	SD	M	SD	
Letter knowledge (26)	2.83	3.54	11.50	7.42	13.80	7.12	UPC=EAV=UGC ^e
Print knowledge (12)	3.50	1.76	6.83	3.06	7.60	2.07	UPC=EAV=UGC ^e
PA (26)	9.33	6.53	13.50	5.50	13.60	5.12	ns
Receptive vocab (84)	34.67	11.36	53.83	8.64	51.00	5.15	UPC<EAC=UGC
Language skills (72)	40.00	11.58	53.33	12.32	57.00	5.79	UPC=EAC=UGC ^e
Working memory ^f (39)	4.33	5.01	10.67	10.43	9.50	1.29	ns
Theory of mind (5)	1.00	1.56	3.50	1.38	4.60	0.53	UPC<EAC=UGC

Notes: (maximum score); UPC = unexpected poor comprehenders; EAC = expected average comprehenders; UGC = unexpected good comprehenders; ^aN = 6, ^bN = 6, ^cN = 5; ^d Less than symbol indicates $p < .05$, and equal symbol indicates non-significant differences; ^e UPC < UGC; ^f Sum of maximum raw scores is shown, but a z- score composite was used for analyses; PA = phonological awareness.

Results revealed a significant difference between the groups on the T1 preschool cognitive measures, Wilk's $\lambda = .08$, $F(14, 16) = 2.88$, $p < .05$. Univariate one-way ANOVAs indicated that there was a significant difference between the groups for T1 letter knowledge, $F(2, 14) = 4.50$, $p < .05$, partial $\eta^2 = .39$; T1 print knowledge, $F(2, 14) = 4.77$, $p < .05$, partial $\eta^2 = .41$; T1 receptive vocabulary, $F(2, 14) = 7.86$, $p < .01$, partial $\eta^2 = .52$; T1 language skills, $F(2, 14) = 4.08$, $p < .05$, partial $\eta^2 = .37$; T1 theory of mind, $F(2, 14) = 10.84$, $p < .01$, partial $\eta^2 = .61$. No significant group difference was found for phonological awareness or working memory.

Post hoc analysis was conducted to examine pairwise comparisons (see Table 6.2). Tukey post hoc tests showed that T1 receptive vocabulary and T1 theory of

mind both significantly differed between expected average comprehenders ($p < .05$) and unexpected poor comprehenders ($p < .01$). However, there was no significant difference between unexpected good comprehenders and expected average comprehenders. Results showed further significant differences between unexpected poor and good comprehenders in T1 letter knowledge, T1 print knowledge and T1 language skills ($p < .05$); however, there was no significant difference between unexpected poor comprehenders and expected average comprehenders or between expected average comprehenders and unexpected good comprehenders.

To illustrate the retrospective performances of unexpected poor comprehenders and unexpected good comprehenders relative to expected average comprehenders on the preschool measures, all seven T1 measures were transformed into z scores and the differences between the unexpected poor comprehenders and the average comprehenders and the differences between the unexpected good comprehenders and average comprehenders were calculated (Li & Kirby, 2014). The discrepancies between unexpected poor and average comprehenders and between unexpected good and average comprehenders were plotted. Results are shown in Figure 6.2.

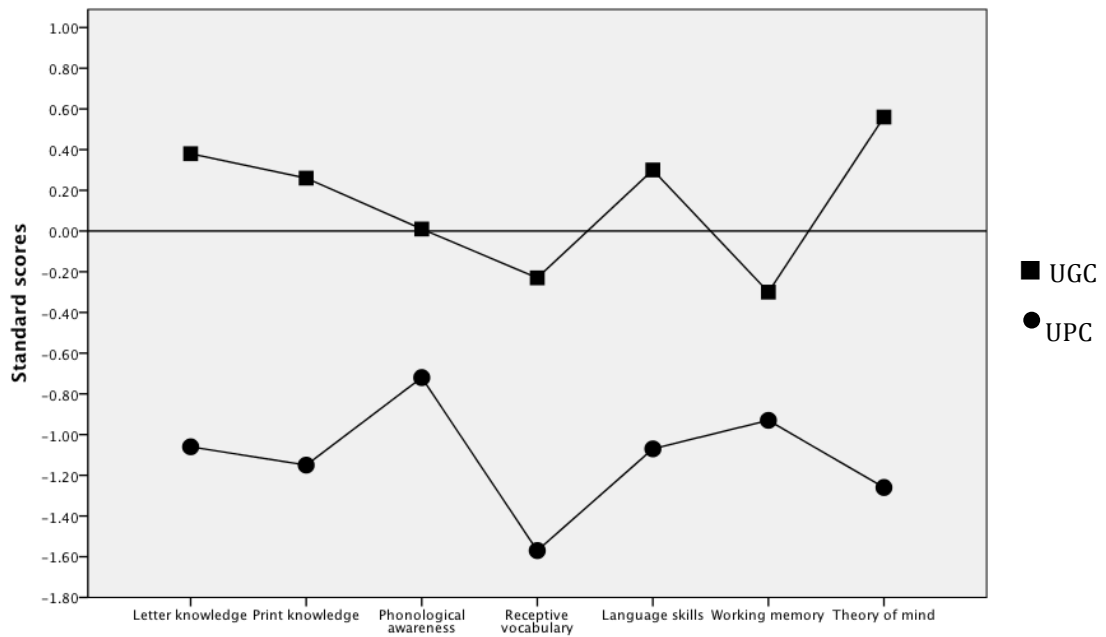


Figure 6.2:

Retrospective performance on T1 preschool cognitive measures for unexpected poor comprehenders (UPC) and unexpected good comprehenders (UGC) relative to expected average comprehenders (EAC). Scores plotted for UPC and UGC groups represent the difference in mean z-scores between UPC and EAC, and UGC and EAC groups, respectively.

6.3.3 Group differences on T1 home literacy (HLE) variables

Further analysis was conducted to investigate retrospective differences between the three groups (unexpected poor comprehenders, expected average comprehenders and unexpected good comprehenders) on preschool home literacy measures (storybook exposure, parental teaching of literacy skills, children's interest in reading and children's narrative engagement). Children's raw scores for HLE measures are shown in Table 6.3.

Table 6.3:

Means and Standard Deviations for Unexpected Poor Comprehenders, Expected Average Comprehenders and Unexpected Good Comprehenders on T1 HLE Measures

<i>Measure</i>	<i>UPC^a</i>		<i>EAC^b</i>		<i>UGC^c</i>	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Storybook Exposure ^d						
- Shared reading (15)	10.33	3.39	12.00	2.61	11.40	0.55
- Library visit (5)	3.17	1.33	2.67	0.52	3.00	0.71
- TRT (15)	4.17	2.48	4.17	3.06	4.20	2.95
Parent teach (20)	14.83	2.23	14.00	1.79	14.00	2.45
Child interest (20)	4.00	0.89	4.17	0.75	4.40	0.55
Child narrative engage (20)	16.83	3.54	15.50	3.33	14.60	3.65

Notes: (maximum score); HLE = Home literacy environment; UPC = unexpected poor comprehenders;

EAC = expected average comprehenders; UGC = unexpected good comprehenders; ^aN = 6, ^bN = 6, ^cN = 5;

^d Raw scores for component factors are reported, but a z-score composite was used for MANOVA.

Raw scores for the component factors of storybook exposure are reported; however, for analyses a composite score was computed from the z scores of each variable. Parental teaching and children's narrative engagement are also composite scores; however these were computed from items measured with the same scales, therefore for each variable, scores were summed to give the composite measure. For details of individual HLE measures see section 3.3.1 and for the computation of composite scores see section 3.3.3. A multivariate analysis of variance (MANOVA) was conducted to test for retrospective differences between the groups on HLE measures. The results indicated that there was no significant difference between the groups, Wilk's $\lambda = .84$, $F(8, 22) = 0.26$, $p = .97$.

6.3.4 Group differences on T2 concurrent variables

Means and standard deviations for variables at T2 (end of Year 1) are reported in Table 6.4. A further multivariate analysis of variance (MANOVA) was conducted

to test for differences between the three groups (unexpected poor comprehenders, expected average comprehenders and unexpected good comprehenders) on concurrent T2 correlates of reading (phonological awareness, receptive vocabulary, narrative comprehension, working memory and theory of mind). Letter knowledge and print knowledge were not measured at T2.

Table 6.4:
Means, Standard Deviations, and ANOVA results for Unexpected Poor Comprehenders, Expected Average Comprehenders and Unexpected Good Comprehenders on concurrent T2 cognitive measures

<i>Measure</i>	<i>UPC^a</i>		<i>EAC^b</i>		<i>UGC^c</i>		Pairwise Comparison ^d
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
PA (40)	23.83	7.47	25.00	5.22	24.00	6.48	<i>ns</i>
Receptive Vocab (120)	62.33	14.64	79.50	7.12	83.20	4.44	UPC<EAC=UGC
Narrative Comp (29)	15.00	5.06	18.50	3.56	22.00	3.67	UPC=EAC=UGC ^e
Working Memory ^f (54)	18.83	2.93	23.33	10.41	25.80	4.60	<i>ns</i>
Theory of mind (12)	2.33	2.80	4.83	1.72	5.00	1.58	<i>ns</i>

Notes: (maximum score); UPC = unexpected poor comprehenders; EAC = expected average comprehenders; UGC = unexpected good comprehenders; ^aN = 6, ^bN = 6, ^cN = 5; ^d Less than symbol indicates $p < .05$, and equal symbol indicates non-significant differences; ^e UPC < UGC; ^f Sum of maximum raw scores is shown, a z-score composite was used for analyses; PA = phonological awareness.

Results revealed a significant difference between the groups on the T2 concurrent cognitive measures, Wilk's $\lambda = .17$, $F(10, 20) = 2.83$, $p < .05$. Univariate one-way ANOVAs indicated that there was a significant difference between the groups on T2 receptive vocabulary, $F(2, 14) = 7.07$, $p < .01$, partial $\eta^2 = .50$, and T2 narrative comprehension, $F(2, 14) = 3.82$, $p < .05$, partial $\eta^2 = .35$. No significant group differences were found for phonological awareness or working memory. Raw

scores suggested that unexpected poor comprehenders showed a weaker performance in T2 theory of mind when compared to the other two groups; however, a one-way ANOVA indicated that the overall group difference for T2 theory of mind was marginal ($F(2, 14) = 2.82, p < .09$). Although not significant, these results may indicate a trend of underperformance in theory-of-mind tasks by poor comprehenders.

Post hoc analysis was conducted to examine pairwise comparisons (see Table 6.4). Tukey post hoc tests showed that unexpected poor comprehenders significantly differed on T2 receptive vocabulary from expected average comprehenders ($p < .05$) and unexpected good comprehenders ($p = .01$). No significant differences were indicated between expected average comprehenders and unexpected good comprehenders on receptive vocabulary. Additionally, tests revealed that performance on T2 narrative comprehension significantly differed between unexpected poor comprehenders and unexpected good comprehenders ($p < .05$); however, there was no significant difference between unexpected poor comprehenders and expected average comprehenders or between expected average comprehenders and unexpected good comprehenders.

The five T2 variables (PA, receptive vocabulary, narrative comprehension, working memory and theory of mind) were transformed into z scores in order to illustrate the relative comparison of performances between unexpected poor comprehenders and average comprehenders and unexpected good comprehenders and average comprehenders for the concurrent reading-related measures. As for the T1 variables, the discrepancies between the scores for

unexpected poor and average comprehenders and between unexpected good and average comprehenders were plotted. Results are shown in Figure 6.3.

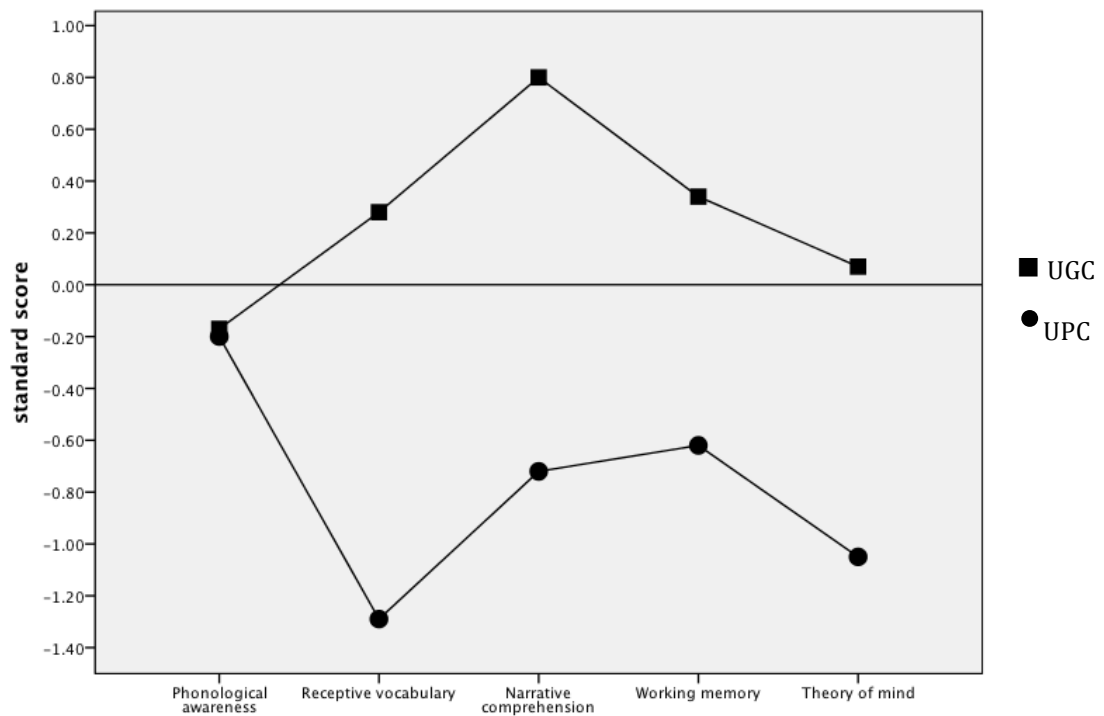


Figure 6.3: Performance on T2 concurrent cognitive measures for unexpected poor comprehenders (UPC) and unexpected good comprehenders (UGC) relative to expected average comprehenders (EAC). Scores plotted for UPC and UGC groups represent the difference in mean z-scores between UPC and EAC, and UGC and EAC groups, respectively.

6.4 Discussion

This study investigated potential early and concurrent sources of reading comprehension strengths and difficulties within a sample of six year old, typically developing children. Three groups of comprehension ability were identified from the larger sample of children who had completed the current three-year longitudinal study from preschool to the end of Year 1: unexpected poor

comprehenders, expected average comprehenders and unexpected good comprehenders. These three group categories have been identified in previous studies with older school-aged children (Li & Kirby, 2014; Tong et al., 2011), but the current study is the first to use this technique to identify these groups in a young UK population.

There were no significant differences between the groups in age, non-verbal ability or word reading efficiency, but there was a highly significant difference in their reading comprehension scores. Six children were identified as unexpected poor comprehenders, accounting for 7.5% of the sample. This finding is broadly consistent with research suggesting that approximately 10% of children, within typically developing populations, are found to have reading comprehension difficulties, despite having adequate decoding and word reading abilities (Nation, 2005b). Nation et al. (2010) identified 8.7% of their sample of eight-year-olds as poor comprehenders. Both studies (using the regression method to identify categories of comprehension ability; Li & Kirby, 2014; Tong et al. 2011) found around 12% of their samples (aged 13 years and 10 years respectively) fitted the poor comprehension category. The smaller number of children identified with poor comprehension skills in the current study may reflect the younger age of the sample. The majority of children showed reading comprehension skills as predicted by their word reading ability, i.e., expected average comprehenders; nevertheless, some of these children may have been experiencing reading comprehension difficulties. Reading comprehension problems may not have been apparent at this young age because the children's word reading efficiency had not yet developed to a degree where a discrepancy between word reading and

reading comprehension ability would be highlighted. Deficits may become apparent at a later stage if children's word reading skills outperform their reading comprehension ability. However, this potential difficulty of identifying poor comprehenders at this early stage does not detract from the advantages of doing so. Early identification allows insights into the potential *causes* of reading comprehension deficits with important implications for future interventions for children with reading comprehension problems.

A further advantage of this approach was the identification of unexpected good comprehenders, as this allowed the investigation of factors that may cause an *advantage* in reading comprehension ability. Five children were identified as unexpected good comprehenders; this was in line with previous studies using the regression technique (Li & Kirby, 2014; Tong et al., 2011) that found approximately equal numbers of unexpected poor and unexpected good comprehenders in their respective samples. Six average comprehenders were selected to ensure the three groups matched for gender, age, non-verbal ability and word reading efficiency (Tong et al., 2010).

Retrospective data were examined to determine whether there were differences between the three groups in preschool (nursery) cognitive and socio-cognitive factors and home literacy experiences. Concurrent (end of Year 1) data were also examined to establish whether differences between the groups remained stable through the early years, following two years of formal literacy instruction. Results revealed that there was a significant difference between the groups in cognitive and socio-cognitive profiles both at preschool and also at the end of Year 1;

however, interestingly, there were no group differences found in the children's home literacy experiences.

6.4.1 Preschool profiles

6.4.1.1 Unexpected poor comprehenders

Initial inspection of the means of the three groups across the preschool variables suggested that those children who were to become poor comprehenders showed weaker performance across all measures relative to those who were later identified as expected average comprehenders and unexpected good comprehenders. This is consistent with previous research (Nation et al., 2002). Nation et al. (2002) reported that the general cognitive ability of children with comprehension difficulties was lower than control children matched for age and word reading ability. However, in this study, as noted above, there were no significant differences between the groups on non-verbal ability, which is consistent with Catts et al. (2006). Nation et al. (2002) suggested the lower performance of the poor comprehenders was primarily due to variation in verbal ability and the results of the current study add some support to this view. Further investigation revealed that unexpected poor comprehenders showed a significantly weaker performance in receptive vocabulary than expected average comprehenders and unexpected good comprehenders.

The association between reading comprehension difficulties and weaknesses in language skills, particularly receptive vocabulary, has been highlighted in several studies with older school-aged children (e.g., Cain et al., 2001; Li & Kirby, 2014; Nation et al., 2004; Nation et al., 2007). Additionally, the studies that examined

retrospective data of poor comprehenders, identified at eight years (Nation et al., 2010) and at 13 years (Catts et al., 2006), also found mild-to-moderate language weaknesses from the age of five. In addition to receptive vocabulary, the current study examined preschool receptive and expressive language skills. Examination of the group means for preschool language skills suggested that unexpected poor comprehenders showed a weaker performance than the other two groups, supporting Nation et al. (2010). Post hoc analysis revealed a significant difference between the poor and good comprehenders, but the difference between poor and average comprehenders was not significant. However, in light of previous findings of language deficits at five years (Catts et al., 2006; Nation et al., 2010), the indication that children, who went on to be identified as unexpected poor comprehenders at six years old, were demonstrating weaker language at three years old than their peers who went on to be identified as unexpected good comprehenders, merits further investigation.

No significant group differences were found in working memory capacity or phonological awareness. The lack of significant difference for working memory was surprising, as previous research with older children has suggested that poor comprehenders show weaker working memory ability than their peers (Oakhill & Cain, 2012). Previous studies with five-year-old children have found mixed results in relation to phonological awareness. Nation et al. (2010) found that poor comprehenders showed the same ability as their peers, whereas Catts et al. (2006) found that five year olds showed a deficit at this stage, but not in the later grades. The current study found no significant group differences; however examination of the group means for both phonological awareness and working

memory revealed that unexpected poor comprehenders performed less well than the other two groups (which were similar to each other). It should be noted that sample sizes were very small and significant differences may be found in larger groups. The need for further research with a larger sample is indicated as the lower scores achieved by the unexpected poor comprehenders might potentially indicate a level of delayed development in these skills that may impact on their acquisition of language and reading skills.

In contrast to previous studies (Nation et al., 2010), a group difference was found for preschool letter knowledge, and for print knowledge. Similarly to performance in preschool language skills, examination of the group means showed that unexpected poor comprehenders performed less well than both of the other groups; however, also similarly, post hoc tests showed only a significant difference between poor and good comprehenders. There was no significant difference in either of these measures between the expected average comprehenders and unexpected poor comprehenders. Nevertheless, as with preschool language skills, the small sample size should be noted and further research is required to investigate these factors in larger groups. Poorer performance in letter knowledge and print knowledge may indicate potential developmental delays in the skills that underlie word-level reading, which may contribute, in part, to children's later reading comprehension problems.

The role of theory of mind in the development of early reading comprehension has not been explored in previous research. Therefore, findings of the current study are novel and highlight an important area for future research. Children

identified as unexpected poor comprehenders showed significantly weaker performance in false belief tasks at the beginning of preschool than the two other groups. It is possible that the poor performance was linked to their language difficulties, as there is a well-established relationship between theory of mind and language abilities (see Milligan, Astington, & Dack, 2007 for meta-analysis). Alternatively, theory of mind may relate to reading comprehension as an index measure of metacognitive ability (see section 1.5.2 and Chapter 5 for further discussion). As reported in Chapter 5 of this thesis, the current longitudinal research found that preschool theory of mind directly predicted children's reading comprehension at the end of Year 1 over and above language ability. The finding that unexpected poor comprehenders showed a deficit in theory of mind at the beginning of preschool adds further support to this relationship.

6.4.1.2 Unexpected good comprehenders

As noted above, unexpected good comprehenders performed significantly better than poor comprehenders in letter knowledge, print knowledge, receptive vocabulary, language skills and theory of mind; however, in general, unexpected good comprehenders showed a very similar profile to expected average comprehenders. No significant differences were found between unexpected good and expected average comprehenders in any of the preschool measures, but, as noted above, the sample sizes were very small and significant differences may be found in larger groups. The comparison of theory of mind performance of the unexpected good comprehenders relative to the performance of average

comprehenders did highlight a potential trend that unexpected good comprehenders show stronger ability than average comprehenders.

Theory of mind is considered by some researchers to be a domain general ability (Iao, Leekam, Perner, & McConachie, 2011; Perner, 1991; Perner, Mauer, & Hildenbrand, 2011), and evidence has been found linking performance in false belief tasks and other metacognitive tasks (Lecce, Bianco, Demicheli, & Cavallini, 2014; Lecce, Zocchi, Pagnin, Palladino, & Taumoepeau, 2010; Lockl & Schneider, 2007; Perner, Stummer, Sprung, & Doherty, 2002). Research examining the profiles of older school-aged children has identified that poor comprehenders show deficits in higher-order comprehension skills, such as inference making and comprehension monitoring (e.g., Cain & Oakhill, 2006; Oakhill & Cain, 2012). These skills, particularly comprehension monitoring, are considered to be metacognitive processes (Kirby & Savage, 2008). Therefore, it is feasible that early theory of mind, measured by false belief understanding, may index the ability to employ metacognitive strategies. The comparison of unexpected poor and unexpected good comprehenders relative to average comprehenders adds some support to this idea. Results illustrated that unexpected poor comprehenders performed worse than expected average comprehenders and unexpected good comprehenders performed better than average comprehenders (see Figure 6.2). Further investigation of the development of metacognition may provide some insight of the early deficits experienced by children who demonstrate later reading comprehension difficulties. Additionally, it may add further understanding of the development trajectory of those children who go on to be unexpected good comprehenders.

6.4.2 Year 1 profiles

6.4.2.1 Unexpected poor comprehenders

Data at the end of Year 1 yielded a similar pattern to the preschool data, examination of the group means suggested that unexpected poor comprehenders performed less well than their peers across all measures, with the exception of phonological awareness. Finding no group differences for phonological awareness supported previous research that found that levels of phonological processing were indistinguishable between poor comprehenders and their peers after kindergarten (Catts et al., 2006; Nation et al., 2010). The uniformly good scores obtained by the children at six years was not surprising in the current study, as the children had experienced two years of formal literacy instruction, which centers on the teaching of synthetic phonics (Department for Education & Skills (DfES), 2006). Indeed, the means for the phonological awareness tasks were almost identical for all three groups.

Intensive phonics instruction in current UK teaching practice may have given all children a boost in their word-level skills. As a result, some of the children who might have been identified as “garden variety poor readers” are now demonstrating a poor comprehender profile, as a result of enhanced word reading skills. In other words these children may be able to successfully decode words beyond that that would be expected from their general ability, but do not have sufficient comprehension skills to complement that ability, and therefore struggle to comprehend passage reading. As noted above, the unexpected poor comprehenders did begin preschool with weaker phonological awareness than the other two groups; however the difference between the groups was not

significant. Therefore, particularly in light of other research that found no deficit in the phonological processing of poor comprehenders, the results would suggest that children's phonological ability was not playing a role in their reading comprehension difficulties.

Consistent with the preschool results, and in contrast to previous research (Oakhill & Cain, 2012), no significant group difference was found for working memory at the end of Year 1. However significant group differences were found for the language measures, consistent with previous research that suggests that the language deficits experienced by poor comprehenders endure throughout the early years (Catts et al., 2006; Nation et al., 2010). As in preschool, unexpected poor comprehenders showed a significantly weaker performance in receptive vocabulary than both average and good comprehenders. Additionally, they showed a significantly weaker performance than unexpected good comprehenders in narrative comprehension.

A comparison between the three groups of children's theory-of-mind ability showed that unexpected poor comprehenders continued to perform below the other two groups. However, the differences were not found to be statistically significant. At six years, Happé's Strange Stories (Happé, 1994; O'Hare et al., 2009) were used to assess children's theory of mind. This was an advanced test of theory of mind and our range of scores was limited, perhaps suggesting that the test was not sufficiently sensitive to capture individual differences in this young age group. Additionally, the Strange Stories task focuses on social understanding and may not tap into metacognitive abilities in the same way as false belief tasks.

Further research with larger samples is needed, using a range of metacognitive assessments (for example, measures of source monitoring; Bright-Paul, Jarrold, & Wright, 2008; O'Neill & Gopnik, 1991), in addition to theory-of-mind tasks, to examine the metacognitive abilities of poor and good comprehenders throughout the early years to provide insight into its role in the acquisition of reading comprehension.

6.4.2.2 Unexpected good comprehenders

In Year 1, unexpected good comprehenders significantly differed from unexpected poor comprehenders in both receptive vocabulary and narrative comprehension. However, as in preschool, there was no significant difference between unexpected good comprehenders and expected average comprehenders for any of the Year 1 measures. Nevertheless, the group means indicated a trend that unexpected good comprehenders performed better in narrative comprehension than average comprehenders, suggesting that even at six years old reading comprehension ability may be enhanced with stronger language skills. This adds some support to recent views that suggest that oral language skills are crucial to the development of early reading comprehension over and above the limitation of word reading ability (Bianco et al., 2012; Paris & Paris, 2003).

6.4.3 Summary

In summary, children who went on to be identified as poor comprehenders began preschool with significantly lower receptive vocabulary knowledge than those

who became average or good comprehenders and this deficit remained through to Year 1. They also showed significantly weaker letter knowledge, print knowledge and language skills at the beginning of preschool than unexpected good comprehenders, suggesting that they may experience some developmental delay in the skills that underpin reading and reading comprehension skills.

The language weakness also remained until Year 1, when poor comprehenders demonstrated significantly weaker narrative comprehension skills than good comprehenders, suggesting that successful reading comprehension is underpinned by strong language skills, even at its acquisition. Previous research has suggested decoding is the limiting factor in reading comprehension in the early years (Oullette & Beers, 2010; Vellutino, Tunmer, Jacard, & Chen, 2007). The current study has provided evidence to support recent research that has suggested that language ability has a greater influence on early reading comprehension than has, until recently, typically been represented in the literature (Bianco et al., 2012; Dickinson, Golinkoff, & Hirsch-Pasek, 2010; Paris & Paris, 2003).

Unexpected poor comprehenders did not demonstrate any significant differences in their phonological awareness or working memory capacity at either time point. Also their preschool home literacy experiences were no different from their peers. They experienced similar frequencies of storybook exposure and parental teaching, and were reported by their parents to show a similar level of interest in literacy activities. However, unexpected poor comprehenders were found to have had significantly weaker preschool theory-of-mind ability than those children

that went on to be average or good comprehenders. Additionally, comparison of group means suggested that unexpected good comprehenders showed stronger preschool theory-of-mind ability than average comprehenders. Although this was not found to be a significant difference in this small sample, it may indicate an important area for future research. Proficiency in language skills may account for these group differences, but theory of mind, particularly false belief understanding, indexes metacognitive ability (Perner, 1991) and it may be the availability of metacognitive strategies that influences reading comprehension. The influence of metacognition in the acquisition of reading comprehension remains unexplored and merits further investigation.

6.4.4 Limitations

The current study took a novel approach to investigate potential deficits underlying poor comprehension in children who show adequate decoding skills. In addition, it investigated potential causal factors for *enhanced* reading comprehension within a group of children who demonstrated unexpectedly good comprehension ability relative to their decoding skills. This approach aimed to identify very early cognitive and socio-cognitive profiles. Although this allowed current knowledge to be extended to a younger population, it does bring some intrinsic limitations that should be noted. Assessing three-year-old children is challenging and finding reliable age-appropriate tasks is difficult. Although children completed a series of assessment sessions, most constructs were measured within a single session. It may have been more reliable to measure constructs with a battery of tasks over several days than to rely on limited tasks

in single sessions (Shepard, Kagan, & Wurtz, 1998). Additionally, at six years old reading comprehension is very much constrained by word reading ability and although there is some evidence that individual differences remain stable from this early age (Nation et al., 2010), reading comprehension should be reassessed at a later stage to clarify whether the observed differences were stable.

A key limitation is the small number of participants in each group. The number of children who were identified as poor comprehenders, relative to the sample as a whole, was consistent with previous research, but the results of the analysis should be interpreted with caution due to the very small sample, which has implications both for reliability and also in terms of statistical power.

Additionally, the multifaceted nature of reading and reading comprehension involves a complex range of factors and interactions, which changes over time (e.g., Silinskas, Leppänen, Aunola, Parrila, & Nurmi, 2010; Storch & Whitehurst, 2002). This study aimed to measure a range of constructs, but additional factors such as other measures of executive function and different aspects of metacognition may have provided further insight. Additionally, the majority of home literacy measures were collected from a parent questionnaire. Alternative observation and interview methods may have yielded a more sensitive measure of children's home literacy experiences. It would also have been helpful to include home literacy measures in Year 1, as changing practices may have contributed to individual differences in reading comprehension.

6.4.5 Conclusion and implications

Previous research has suggested that children identified as poor comprehenders in adolescence or mid-primary years consistently show weakness in language abilities both concurrently and retrospectively from kindergarten (Catts et al., 2006; Nation et al., 2010). Research has also demonstrated that these children do not typically show deficits in their phonological awareness or word reading ability. The current study adds to this research in several ways. Firstly, this study took a novel approach to identifying poor comprehenders in a young, typically developing UK population. Previous studies examining retrospective profiles have used poor reading comprehension scores to identify poor comprehenders and then compared their profiles with a control group matched for age and word reading ability (e.g., Nation et al., 2010). The current study followed a regression method, previously used with groups of older children (Li & Kirby, 2014; Tong et al., 2010) to identify to three groups (unexpected poor, expected average and unexpected good comprehenders) based on the comparison of children's actual reading comprehension scores relative to scores predicted from their age, non-verbal ability and word reading efficiency (including real and pseudo words). The identification of the three groups allowed not only the comparison of profiles between unexpected poor comprehenders and average comprehenders to highlight potential *deficits* underlying poor reading comprehension, but also the comparison of unexpected good comprehenders to average comprehenders to investigate potential causal factors for *enhanced* reading comprehension.

Secondly, current knowledge was extended to a younger population. Children were assessed in passage reading comprehension at six years and retrospective

data were examined to identify cognitive and socio-cognitive profiles at three years. Therefore, this study was able to highlight the preschool cognitive and socio-cognitive abilities, which characterized the children who went on to show later reading comprehension difficulties and those who showed superior reading comprehension ability. The longitudinal design of the current study allows insights into the potential causes of reading comprehension deficits (and advantages). The study has important implications not just in terms of developing ways to identify children at risk of developing difficulties, as early as possible, but also in terms of informing future interventions for children with comprehension problems.

Finally, the current study considered the impact of factors that have not been included in previous research, but which may play an important role in the acquisition of reading comprehension skills. It considered preschool home literacy experiences, working memory capacity and theory-of-mind ability in the profiles of poor, average and good comprehenders.

The current study has highlighted that children demonstrating reading comprehension weaknesses at six years old began preschool with significantly poorer receptive vocabulary and theory-of-mind ability than their peers. They also showed weaknesses in other pre-reading skills (e.g., letter sound knowledge) at the beginning of preschool when compared to those children who became good comprehenders. However, the question of why these children show these deficits remains unanswered. It appears that the children began preschool with similar home literacy experiences, but perhaps they did not gain as much benefit from

these experiences as their peers, even though their working memory and phonological awareness skills did not appear to be significantly different from their classmates. Further similar, longitudinal research, but on a considerably larger scale, is needed to enable the identification of larger groups for greater reliability and power in statistical analyses. In particular, research is needed to determine the contribution of theory of mind and metacognitive ability. This may be a promising area of research, as it is relatively easy to assess and could therefore be a crucial tool in identifying young children at risk from developing later reading comprehension difficulties.

Chapter 7 General Discussion

7.1 *Summary of key aims and findings*

The longitudinal research reported in this thesis investigated early predictors of the acquisition of reading comprehension in a sample of typically developing children (initially aged three to four years and following them through to six years old). The research formed part of a larger project investigating children's early acquisition of reading. The research questions were addressed primarily through direct assessment of the children, with the exception of the home literacy environment, which was assessed through a parent-report questionnaire. Firstly, the study investigated the contribution of children's pre-school home literacy experiences to their cognitive abilities at the beginning of preschool nursery and before the commencement of formal literacy instruction. It went on to examine longitudinal relationships from the home literacy experiences to children's word reading and listening comprehension sixteen months later, after a year of formal literacy instruction. Secondly, the study examined the early cognitive precursors of reading comprehension acquisition within the framework of the Simple View of Reading (SVR; Gough & Tunmer, 1986; Hoover & Gough, 1990). In particular, it aimed to determine the direct and indirect predictive pathways from children's preschool cognitive abilities at three years to reading comprehension skills at the age of six. Thirdly, the role of theory of mind in reading comprehension was explored to determine whether it contributed to the development of reading comprehension over and above the two dimensions of the SVR framework. Finally, individual differences within children's reading comprehension skills at six years old were explored to identify children with *poorer* reading

comprehension than would be expected from their word reading ability (unexpected poor comprehenders) and children with *advanced* reading comprehension than would be expected from their word reading ability (unexpected good comprehenders). The retrospective and concurrent cognitive and social cognitive (theory of mind) abilities of these children were compared to the performance of children demonstrating average reading comprehension ability, to highlight potential causal indicators of later and concurrent reading comprehension deficits and strengths.

7.1.1 The contribution of the home literacy environment (HLE)

Two distinct preschool home literacy practices, namely children's storybook exposure (including frequency of shared book reading) and parental teaching (teaching of letters and words) emerged from the current data, supporting Sénéchal and LeFevre's (2002) Home Literacy Model, but importantly extending it to a younger population. Each of the two types of literacy activities at home was found to influence a different pre-reading skill, that is, ability in one of the early indicators of reading ability (receptive vocabulary, print knowledge, phonological awareness, letter knowledge). Storybook exposure directly predicted receptive vocabulary, which supports previous research (e.g., Fritjers, Barron, & Bruello, 2000; Hood, Conlon, & Andrews, 2008; Sénéchal, 2006; Sénéchal & LeFevre, 2002). Parental teaching directly predicted letter knowledge, which also supports previous research with five-year-old children (Evans, Shaw, & Bell, 2000; Hood et al., 2008; Martini & Sénéchal, 2012; Sénéchal, 2006; Sénéchal & LeFevre, 2002), but extends this finding to a younger three-year-old sample.

No direct predictive pathways were found from either of the home literacy practices to print knowledge or phonological awareness (PA). There were, however, indirect pathways to both. Storybook exposure and parental teaching indirectly contributed to print knowledge via receptive vocabulary and letter knowledge respectively. The lack of direct pathways from home literacy to print knowledge was not surprising, as research has shown that children do not focus on the print during shared storybook reading (Evans & Shaw, 2008; Ezell & Justice, 2000; Levy, Gong, Hessels, Evans, & Jared, 2006) and, although less is known about parental teaching, particular at this very young age, it seems feasible that parents would focus on teaching letter sounds and names rather than more general print concepts.

Surprisingly, there was only one indirect pathway to PA, from parental teaching to PA via letter knowledge. This was in contrast to Home Literacy Model, which demonstrated two indirect pathways from storybook exposure to PA via receptive vocabulary, and from parental teaching via emergent literacy. The current contrasting result may be due to the younger age of the children, as they may not have yet developed sufficient breadth of vocabulary to influence PA (Metsala, 1999). At three years old, regression analysis revealed that letter knowledge was the strongest predictor of PA, suggesting that it was providing an early foundation for developing phonological skills (c.f. Foy & Mann, 2006). The relationship was reciprocal as PA, in addition to parental teaching, was also a significant predictor of letter knowledge. These findings are consistent with the view that the relationship between PA and reading is complex and bidirectional,

making simple causal explanations difficult to establish (Castles & Coltheart, 2004).

Children were reassessed sixteen months later, aged five years, following a year of formal literacy instruction. The study used the SVR as framework for assessing skills *underlying* reading comprehension and, as such, children were assessed in listening comprehension and single word reading to measure the linguistic and decoding components of the SVR respectively. The results replicated the early pathways of the Home Literacy Model (Sénéchal & LeFevre, 2002). The Home Literacy Model shows direct pathways from storybook exposure to language (composite of receptive vocabulary and listening comprehension) and from parental teaching to letter and word knowledge at five years old. However, the Canadian data used to build the model reported that children had not received any formal literacy instruction at this age (Sénéchal, 2006; Sénéchal & LeFevre, 2002). Sénéchal and LeFevre's (2002) HLE model demonstrates that after the introduction of formal literacy instruction, when children were aged six, the pathways became indirect via early language and reading skills. In the current study, although the children were also five years old, they had already received a year of formal literacy instruction. The current research could therefore shed light on whether the very early onset of literacy instruction in the UK, at a time when children have more limited linguistic and cognitive resources, had a direct impact on the shape of the emerging reading model.

Results demonstrated the importance of early literacy experiences at home. Parental teaching uniquely contributed to single word reading directly and

indirectly via letter knowledge. Also, storybook exposure continued to exert influence to the language pathway. It not only indirectly contributed to listening comprehension via receptive vocabulary, but also directly, in combination with children's interest in literacy. As such, these findings are broadly consistent with previous findings for the HLE model (Hood et al., 2008; Sénéchal & LeFevre, 2002), but extend them to a younger sample of children who had already completed a year of formal literacy instruction. The implications of these results suggest that early home literacy experiences are still significant beyond the introduction of formal literacy instruction, suggesting that changes in the influence of literacy activities at home may be due to children's maturation rather than the introduction of formal literacy instruction at school.

Children's interest in literacy activities has not been formally investigated at this young age. In the current study, parental report of children's interest in literacy activities before they began preschool did not significantly contribute to children's pre-reading skills (receptive vocabulary, print knowledge, PA and letter knowledge) at three years. However, consistent with research with older children that suggests that an interested child may gain additional benefit from home literacy practices over an uninterested child (Martini & Sénéchal, 2012; Baroody & Diamond, 2012), children's interest in literacy activities at home did significantly correlate with storybook exposure and, as noted above, it directly contributed to listening comprehension (in combination with storybook exposure) sixteen months later at the end of Reception. Additionally, children's interest in literacy activities uniquely contributed to single word reading at the end of Reception.

Previous research has yielded mixed results for the influence of children's early interest in literacy. Sénéchal et al. (1996) found that it accounted for unique variance in vocabulary at five years, but other researchers failed to find a significant relationship (e.g., Hood et al., 2008). The relationship between children's interest and emergent reading skills (e.g., word reading) has also been demonstrated in older children (Martini & Sénéchal, 2012), but the finding that children's interest at *three* years predicted their single word reading at five years was novel. It suggests that benefits gained by motivated readers (e.g., Matthew effect; Stanovich, 1986) might originate at the earliest development of literacy-related skills.

In sum, the results of the current study demonstrated the complex nature of relationships between children's home literacy experiences, and their contribution to the development of pre-reading and emergent literacy skills. Supporting and extending previous research (Hood et al., 2008; Sénéchal, 2006; Sénéchal & LeFevre, 2002; Stephenson, Parrila, Georgiou, & Kirby, 2008) two clear pathways emerged from the home literacy experiences of three year olds to their emergent literacy at five years: storybook exposure to oral language skills and parental teaching to decoding skills. Clearly this demonstrates that both types of home literacy practices are important for children's developing literacy skills and the influence of these experiences endures beyond the beginning of full-time education.

7.1.2 The cognitive precursors of early reading comprehension

The current longitudinal study examined cognitive precursors underpinning the acquisition of reading comprehension within the framework of the SVR (Gough & Tunmer, 1986; Hoover & Gough, 1990). Results showed a high degree of overlap and shared variance between the preschool variables. Previous research has reported a close relationship between the two dimensions of the SVR, i.e., between code-related (letter knowledge, print knowledge and PA) and oral language skills in the early years, when children were four to six years old (Dickinson & McCabe, 2001; Kendeou, van den Broek, White, & Lynch, 2009b; NICHD, 2005). The current research provides evidence to extend these findings to a younger population who, importantly, had had no formal literacy instruction and were non-readers. Strong correlations were found between children's abilities in all the code-related and oral language skills as they began preschool. However, consistent with previous research (e.g., Kendeou et al., 2009b; Storch & Whitehurst, 2002), the degree of the relationship between the two dimensions of the SVR decreased through the early years. By the end of Year 1, the relationship between word reading efficiency and linguistic comprehension was non-significant, adding further evidence to support the distinction between components of the SVR.

Further evidence to support the two dimensions of the SVR was found from regression analyses. Two independent predictive pathways emerged from preschool data to reading comprehension at the end of Year 1. Consistent with the SVR framework, concurrent word reading efficiency and linguistic comprehension both uniquely contributed to reading comprehension when

children were six years old and evidence was found to suggest that each of the two components were indeed underpinned by different skill sets from preschool through the early years. Word reading efficiency was supported through the development of letter knowledge and single word reading. Linguistic comprehension was supported through a range of oral language skills, including receptive vocabulary and listening comprehension. The results are consistent with previous evidence of independent pathways in school-aged children (Kendeou et al., 2009b; Storch & Whitehurst, 2002), but also extend the origins of the pathways to a younger population. As such, evidence demonstrates that the roots of the separate dimensions, argued by the SVR to support the development of reading comprehension, can be found in very young pre-readers as they began preschool.

The implication of these findings suggests that not only are *both* skills sets (or dimensions) crucial to emergent literacy and the acquisition of reading comprehension, but also that the level of children's abilities as they begin preschool continue to exert influence through the early years. The former adds evidence to research that has suggested that oral language contributes to emergent literacy much earlier than has typically been represented in the literature (e.g., Bianco et al., 2012; Paris & Paris, 2003). The latter is consistent with research that has suggested that individual differences in cognitive abilities remain relatively stable through the early years and that early competencies contribute to later performance (Schatschneider, Fletcher, Francis, Carlson, & Foorman, 2004).

The preschool measure of print knowledge was found to uniquely contribute to concurrent preschool measures, but it did not uniquely contribute to either predictive pathway. In contrast, phonological awareness (PA) contributed to both pathways, although not until the end of Reception (T3). PA did not uniquely account for variance in T2 decoding (letter knowledge and single word reading). However, at T2, children had experienced a term of formal literacy instruction, which focused on the teaching of systematic synthetic phonics (SSP; Department for Education and Skills, 2006) closely linking PA and knowledge of letter sounds. Indeed, the two variables were strongly correlated at this time, which would suggest that there was a high degree of shared variance, which may have accounted for the lack of unique contribution.

Nevertheless, as noted above, preschool PA did uniquely contribute to single word reading and listening comprehension at T3, when children were aged five. The relationship between PA and word reading is well established (for meta-analysis see Melby-Lervåg, Lyster, & Hulme, 2012), but its contribution to listening comprehension has not been previously reported within a sample of typically developing readers. As such, this contributes a relatively novel finding, but is consistent with a training study with seven-year-old at-risk readers that found that PA improved later listening comprehension (Poskiparta, Niemi, & Vauras, 1999). The contribution of PA to listening comprehension was important to note, as it provides evidence to suggest that the intensive focus on phonics instruction in the early years, aimed at developing decoding skills, may also directly benefit the development of listening comprehension skills.

As has been shown in the current study and in other recent research, the skill sets underpinning the dimensions of the SVR are, in general, independent, but they may not be completely distinct (Tunmer & Chapman, 2012a). From their study with a sample of seven year olds, Tunmer and Chapman (2012a) suggested vocabulary knowledge might be the link between the two dimensions. The current study did not find evidence of a direct or predictive link between the dimensions of word reading and linguistic skills at any time point. Indeed, results suggested that at the very early stages of reading and the acquisition of reading comprehension PA might be the linking factor. However, children in the current study were only six years old at the final assessment and it may be vocabulary knowledge contributes to word reading skills after they become more established.

Consistent with previous research (Catts, Fey, Zhang, & Tomblin, 2001; Puolakanaho et al., 2007; Schatschneider et al., 2004), preschool letter knowledge was a significant predictor of later single word reading and reading efficiency, albeit indirectly after controlling for earlier decoding ability. It also uniquely contributed to variance in Year 1 reading comprehension over and above word reading efficiency. The direct relationship between letter knowledge, at three years old, and later reading comprehension, at six years, is a novel finding, but is consistent with the finding that letter knowledge at five years old predicts reading comprehension deficits at seven years (Catts et al., 2001). In the current study, the relationship between early letter knowledge and later reading comprehension may reflect that word reading is still a relatively effortful process requiring efficient access to letter knowledge for decoding. As such, this may be

another example of where early competency, and therefore more exposure and experience using the process, leads to later benefit (Schatschneider et al., 2004). Alternatively, particularly as letter knowledge uniquely contributed after controlling for word reading efficiency, it may be indexing other factors, such as home literacy effects or perhaps working memory capacity, which continue to influence literacy development through the early years.

Evidence emerged from the current study to suggest that children's oral language comprehension played a crucial role in the acquisition of reading comprehension. Whilst other studies have shown the importance of language to early listening and narrative comprehension (e.g., Bianco et al., 2012; Dickinson, Golinkoff, & Hirsh-Pasek, 2010; Paris & Paris, 2003), these findings extend the early importance of language skills to an early measure of reading comprehension. The degree to which concurrent language skills contributed to reading comprehension was surprising, as it accounted for a greater percentage of unique variance in reading comprehension than concurrent word reading efficiency. The types of measures used to assess language and reading comprehension may have influenced this result. The language tasks measured broader language skills, including vocabulary and narrative comprehension. The reading comprehension task required passage reading followed by open questions that required inference-making skills and general knowledge, in addition to rich language skills. The smaller contribution from word reading efficiency may have reflected that reading still required a high level of decoding in these young children, therefore, there may have been a considerable degree of shared variance with single word reading and, indeed, letter knowledge. Nevertheless, in contrast to previous

accounts that suggest that oral language skills do not become influential until after the age of seven (Kendeou et al., 2009b; Vellutino, Tunmer, Jaccard, & Chen, 2007), the results demonstrated that oral language significantly contributed to the acquisition of reading comprehension before word reading had become fully fluent.

Throughout the study, language was assessed through a variety of tasks, with the aim of obtaining a richer measure of language skills. Dickinson et al., (2010) suggests that the contribution of oral language to reading comprehension may be underestimated in the literature due to use of limited language measures. Results from the current study add support to this argument. Firstly, as noted above, Year 1 linguistic comprehension accounted for a considerable degree of unique variance in reading comprehension. The language assessment at this time consisted of receptive vocabulary and a narrative comprehension task. The broader measure accounted for greater variance than vocabulary alone. This supports recent research that found that narrative skills contributed to reading comprehension at an earlier age than is general discussed in the literature (Bianco et al., 2012). Secondly, as expected from previous research (Florit, Roch, Altoè, & Levorato, 2009; Lepola, Lynch, Laakkonen, Silvén, & Niemi, 2012), results showed that listening comprehension at five years old (T3) significantly contributed to linguistic comprehension at six years old (T4). Interestingly, however, preschool language (T1) (receptive vocabulary, expressive and receptive language skills) also significantly contributed to T4 linguistic comprehension over and above listening comprehension. These findings highlight that it is crucial to take a broad perspective when examining the contribution of

oral language skills. The current results demonstrated that listening comprehension, language skills, narrative comprehension, in addition to vocabulary, all uniquely contributed to later reading comprehension, via the linguistic comprehension component of the SVR.

In general, results from the current study indicated that the SVR provides a useful framework to examine the cognitive abilities that underpin the acquisition of reading comprehension. Two separate predictive pathways were demonstrated from early preschool variables to the acquisition of reading comprehension, supporting the two-component SVR model (Kendeou et al., 2009b; Storch & Whitehurst, 2002; Tunmer & Chapman, 2012a). Importantly, evidence was found to indicate that *both* pathways are crucial to the acquisition of reading comprehension, even from this early age. The two dimensions accounted for the contribution of preschool variables to reading comprehension with two exceptions. The first, as noted above, was the direct contribution of preschool letter knowledge to later reading comprehension. The second was working memory, which made a marginally significant contribution to later reading comprehension over and above the SVR dimensions (measured here as reading efficiency and linguistic comprehension). Overall, in this study, the two dimensions accounted for around half of the variance in reading comprehension, which, as others have noted (e.g., Conners, 2009; Joshi & Aaron, 2006; Kirby & Savage, 2008), leaves a significant amount of variance in reading comprehension that remains unexplained.

7.1.3 Theory of mind and reading comprehension

The relationship between theory of mind and reading comprehension was explored to determine whether theory of mind would account for unique variance in reading comprehension beyond that explained by the two dimensions of the SVR. Results showed that preschool (T1) theory of mind (measured through explicit first-order false belief understanding) and theory of mind in Reception (T2) (measured through explicit second-order belief understanding) both directly contributed to reading comprehension abilities at the end of Year 1 (T3), after controlling for non-verbal ability, language and executive function. Concurrent theory of mind (measured with Happé's Strange Stories) did not account for unique variance in reading comprehension at the end of Year 1 (T3).

Interestingly, preschool theory of mind (T1) at three to four years old appeared to account for greater variance than Reception (T2) theory of mind, at four to five years old, supporting previous research that has suggested that *early* theory-of-mind ability is beneficial to later cognitive performance (Lecce, Bianco, Demicheli, & Cavallini, 2014; Lockl & Schneider, 2007).

Further investigation of the influence of *early* (T1) theory of mind revealed that it uniquely predicted variance in reading comprehension at T3 over and above the dimensions of the SVR. There was no significant correlation between preschool theory of mind and later word reading efficiency. However, as expected, there was a strong correlation between theory of mind and linguistic comprehension, consistent with previous research (Milligan, Astington, & Dack, 2007; Pelletier & Astington, 2004; Slade & Ruffman, 2005). Regression analysis revealed that after accounting for the linguistic comprehension component, preschool theory of

mind still accounted for unique variance in reading comprehension. However, there was some reduction in the unique variance explained, suggesting that theory of mind, in addition to its direct effect, may have an indirect effect on reading comprehension, through promotion of linguistic comprehension. Though this relationship was not tested, it is consistent with research that has shown that theory of mind may influence later language development (Milligan et al., 2007; Slade & Ruffman, 2005).

The direct contribution of early theory of mind to later reading comprehension in a young typically developing population is a novel finding. Theory of mind is an early index of metacognition (Flavell, Green, & Flavell, 2000). As noted previously (see sections 1.5.2 and 5.1.1), it is unclear whether this link is due to theory of mind being a socially specialized ability (Baillargeon, Scott, & He, 2010; He, Bolz, & Baillargeon, 2011; Leslie, 2005; Onishi & Baillargeon, 2005) that leads to or facilitates more general or non-social metacognitive abilities (Lockl & Schneider, 2007; Ricketts, Jones, Happé, & Charman, 2013) or whether theory of mind is more domain general and draws on the same underlying ability as other aspects of metacognition (Iao, Leekam, Perner, & McConachie, 2011; Perner, 1991; Perner, Mauer, & Hildenbrand, 2011). Notwithstanding this debate, early theory of mind, particularly false belief understanding, indexes the availability of metacognitive abilities.

The finding that early theory of mind uniquely predicts reading comprehension may be consistent with the suggestion that reading comprehension involves specific metacognitive skills, which may not be central for comprehending spoken

language, particularly comprehension monitoring and the use of repair strategies (Kirby & Savage, 2008). Kirby and Savage (2008) suggest that the SVR framework should consider these metacognitive skills in order to provide a full account of reading comprehension. Results from the current study potentially add support to this argument. If theory of mind indexes metacognitive abilities, it is plausible that it might enhance reading comprehension ability. However, further consideration is required to understand why *early* theory of mind in particular predicts later reading comprehension.

A possible explanation, consistent with the domain general view of theory of mind (Perner 1991), is that gaining an understanding of false belief indexes a 'watershed' availability of metacognitive skills. Therefore, the important factor is *when* children gain false belief understanding. Alternatively, as a more socially specified ability that generalizes or leads to other non-social metacognitive processes, children may benefit from an early theory of mind as it facilitates greater exposure and experiences of employing metacognitive skills, which promotes better reading comprehension skills. In their study within a sample of adolescents with autism spectrum disorders (ASD), Ricketts et al. (2013) also found that theory of mind uniquely contributed to reading comprehension over and above language and word reading skills. They suggested that theory of mind might act as a "gate-keeper" for skills that are necessary for inference making and that it should be an additional component of the SVR model when accounting for reading comprehension in a ASD population. This theory also applies to a young typically developing population, such that early false belief understanding

provided earlier access to the skills required for inference-making, leading to subsequent benefits in the use of higher-order reading comprehension skills.

In sum, the current study demonstrated that early false belief understanding predicted unique variance in reading comprehension over two years later, beyond that explained by the two dimensions of the SVR (word reading and linguistic comprehension). It provided evidence that the SVR may be too simple to fully account for the acquisition of reading comprehension and an additional component, perhaps metacognition, needs to be considered (Ricketts et al., 2013; Kirby & Savage, 2008). The predictive relationship between early false belief understanding and later reading comprehension suggests that it might be another vital step in the acquisition of reading comprehension skills. This has important implications for instruction and assessment. Training in false belief tasks and mental state understanding more generally, which has recently begun to be explored (Lecce et al., 2014), might prove to be beneficial for future reading comprehension skills. Furthermore, early assessment of young children in false belief tasks could provide a relatively simple and early indication of their prospective reading comprehension ability, potentially highlighting those children who may need additional support.

7.1.4 Unexpected poor and unexpected good comprehender profiles

The current study took a novel approach to investigate early cognitive and social cognitive profiles of children identified as unexpected poor and unexpected good comprehenders in a sample of typically developing six-year-old children (Li &

Kirby, 2014; Tong, Deacon, Kirby, Cain, & Parrila, 2011). To date, there has been limited research examining early precursors of reading comprehension difficulties, the majority of research has identified children's reading comprehension problems in the mid-primary years and examined concurrent and later profiles (e.g., Cain, Oakhill, & Bryant, 2004a; Oakhill & Cain, 2012; Ricketts, Bishop, & Nation, 2008). More recently, however, two longitudinal studies have examined early cognitive profiles of poor comprehenders from five years old, by comparing the retrospective data of children identified as poor comprehenders, at eight years old (Nation, Cocksey, Taylor, & Bishop, 2010) and thirteen years old (Catts, Adlof, & Weismer, 2006), with the performances of their peers. The present study extends current knowledge to a younger population and investigated the potential *causes* of reading comprehension advantages and weaknesses through the comparison of both unexpected good comprehenders and unexpected poor comprehenders with a group of their peers who demonstrated expected average reading comprehension ability.

Previous research has found that poor comprehenders identified in later primary or early secondary school years have shown retrospective mild to moderate language deficits from the age of five (Catts et al., 2006; Nation et al., 2010). The current study found evidence to support this research and extend it to a younger population. At the beginning of preschool (T1), unexpected poor comprehenders were found to have significant lower receptive vocabulary than average comprehenders. This deficit remained stable, as poor comprehenders continued to show a significantly weaker performance at the end of Year 1 (T2) than their peers. Unexpected poor comprehenders also showed a weaker performance in

receptive and expressive language skills in preschool (T1) and narrative comprehension at the end of Year 1 (T2). Although their performances were not found to be significantly different from average comprehenders in this small sample, they were significantly different from unexpected good comprehenders suggesting there may be underperformance in other language skills beyond vocabulary.

The cause of these language deficits remained unclear. Unexpected poor comprehenders demonstrated a trend for weaker performances than their peers across all preschool measures, which may suggest a more general developmental delay. However, they did not differ in non-verbal ability or in home literacy experiences. Interestingly, there was a significant difference in preschool theory-of-mind ability between unexpected poor comprehenders and their peers. Early theory of mind, measured through false belief understanding, indexes metacognitive abilities (see Flavell et al., 2000). As successful reading comprehension requires the use of metacognitive processes (e.g., comprehension monitoring and repair; Kirby & Savage, 2008), it is feasible that early false belief understanding may be a precursor to the development of the metacognitive skills needed for reading comprehension. Indeed, this current research project reports that preschool theory of mind directly predicted later reading comprehension (see Chapter 5). This study of poor and good comprehenders adds further evidence to this relationship, as not only did it find that unexpected poor comprehenders showed significantly weaker theory-of-mind skills than average comprehenders, but also that there was a trend where unexpected good comprehenders showed a superior performance to average comprehenders. The

latter relationship was not significant in this small sample, however, as a novel finding in research investigating the acquisition of reading comprehension; it merits further investigation with a larger sample.

Unexpected good comprehenders broadly showed a similar profile to expected average comprehenders in preschool (T1) and in Year 1 (T2), with potentially, two notable exceptions. The first, as noted above, was a trend towards stronger theory-of-mind performance in preschool (T1). The second was a trend towards superior narrative comprehension skills in Year 1. The difference between good and average comprehenders was not found to be significant, but as previously noted, the sample size was very small so statistical power was an issue. The trend towards stronger performance in narrative skills by good comprehenders is potentially interesting when considering the development of reading comprehension within the SVR framework. Much research has suggested that the language component of the SVR does not become influential until after the age of seven when children have established a degree of fluency in decoding skills (e.g., Vellutino et al., 2007). The current study adds evidence to alternative research that has suggested that language comprehension is crucial even through the earliest development of reading comprehension (Bianco et al., 2012; Paris & Paris, 2003). In the current study, children with enhanced language comprehension skills showed a trend towards stronger reading comprehension ability, relative to the level predicted by their word reading ability, than their peers. This potentially has important implications for early literacy instruction. The present focus in the UK is on decoding aspects of reading (Department for Education and Skills, 2006), but evidence is mounting to indicate the importance

of incorporating instruction of language comprehension skills in these early years (Bianco et al., 2012; van den Broek, White, Kendeou, & Carlson, 2009).

7.2 Implications of the findings

In general, the Simple View of Reading (SVR; Gough & Tunmer, 1986; Hoover & Gough, 1990) provides a good, overarching framework to understand the precursors of reading comprehension. Informing researchers and practitioners in the complex nature of reading comprehension benefits from a simple framework, particularly as the interaction and contribution of factors change throughout early development (Storch & Whitehurst, 2002; Whitehurst & Lonigan, 1998).

The current study extends the SVR to a younger population, demonstrating that the two separate skill sets that underpin reading comprehension - one supporting word reading skills and the other oral language skills - can be found in three year old non-readers as they begin preschool nursery. This finding is crucial for informing early years instruction not only at school, but also at home. The results here demonstrate that *both* oral language and decoding skills should be supported from the earliest stages of education, and indeed also at home before children begin preschool.

Long-term beneficial gains, from preschool educational and home experiences to development through the early years, have been demonstrated in a large-scale (3000+ children) longitudinal project focusing on the effectiveness of education in the early years (Sammons et al., 2004). The current study adds further evidence to the advantages of early gains. It demonstrates that individual differences in

pre-reading skills at the beginning of preschool remained relatively stable through the early years, reinforcing the significance of children's literacy experiences at home. This study extends knowledge of the home literacy environment (HLE) to three-year-old children and highlights that these very young children gained benefit from both types of home literacy practices: storybook exposure and direct parental teaching of letters and words. Preparing young children for literacy at school may result in enduring advantages through the early years.

These findings have implications for early years practice. In this study, there was a high degree of correlation between the pre-reading skills, suggesting that growth in one skill would directly or indirectly promote growth in the others. Parents should be encouraged to explicitly teach letter sounds and words to their children before they begin school, perhaps by using shared storybook reading as opportunities to draw children's attention to the print. Furthermore, children's interest in literacy activities contributed to later listening comprehension and word reading ability, therefore, parents should give equal importance to fostering children's interest in reading by taking a balanced approach to ensure that home literacy activities are positive and enjoyable experiences. Overall, this reinforces that the development of information and simple strategies for parents encouraging a variety of literacy practices at home, before children begin school, may be beneficial for emergent literacy and beyond.

Although the sample participating in the current study was from a relatively homogenous middle class background, the benefits of home literacy can be

extended to all populations. Informing parents and encouraging children's exposure to print, including library visits, before they start school may help to ameliorate the educational disadvantages that have been identified in children from lower SES backgrounds and those with English as a second language (Sammons et al., 2004).

The current study found that oral language skills played a greater influential role throughout the early years than is typically reported in the literature (Dickinson et al., 2010). At six years old linguistic comprehension accounted for greater unique variance in concurrent reading comprehension than word reading efficiency. This result may be an artifact of the type of assessment. Children were assessed in range of language skills to capture a richer measure and reading comprehension was assessed with passage reading and open questions, which tapped oral language, inference-making skills and general knowledge in addition to decoding skills. At six years old, children were very young for reading comprehension assessment, and, typically, in the limited studies that have assessed children at this age, cloze tasks have been used and these have been shown to highly relate to decoding skills (e.g., Nation & Snowling, 1997; Francis, Fletcher, Catts, & Tomblin, 2005), which may account for contrasting results of this study. Nevertheless, the significant contribution of language skills was demonstrated from preschool, Reception, and Year 1, suggesting that a range of oral language skills, including vocabulary, expressive language, receptive language and narrative skills are all crucial in the acquisition of reading comprehension skills.

The findings in this thesis are critical for informing early years literacy instruction. The current UK literacy curriculum is based on the SVR (Rose, 2006); however, the early focus is very much on systematic synthetic phonics (SSP; Department for Education & Skills, 2006). Intensive phonics training fosters early decoding skills and young children are expected to reach a prescribed level of ability at the statutory phonics screening check at the end of Year 1 (Department for Education, 2012). The high degree of phonics teaching may partially explain why oral language was found to account for greater variability in reading comprehension than has been previously considered in the literature. In languages that have transparent orthographies, e.g., Finnish, Italian, Greek, where there is greater consistency in mappings between phonemes and graphemes, children typically develop accurate and fluent reading skills at an earlier stage relative to those learning English (Seymour, Aro, & Erskine, 2003; Ziegler & Goswami, 2005). Research examining reading comprehension in languages with transparent orthographies has found that oral language significantly contributed at an earlier stage than is typically found in English speaking populations (Babayigit & Stainthorp, 2014; Florit & Cain, 2011; Kendeou, Papadopoulos, & Kotzapooulou, 2013). The current study demonstrated a similar pattern, which may suggest that many of the children have reached a sufficient level of decoding ability, as a result of phonics training, that reduced the constraints of word reading abilities.

This may be considered to be an advantage in children's early literacy development; however, some caution should be noted. English has an opaque orthography, where phonemes can be written in several ways and graphemes

may have multiple pronunciations. It includes many words with irregular spelling patterns, which can only be read through exposure and instruction, therefore, decoding skills are not sufficient for fluent and efficient reading; exposure to irregular words is also crucial. Furthermore, evidence from the current study indicated that oral language skills, including vocabulary and narrative skills, are also crucial to the acquisition of reading comprehension. As a consequence, notwithstanding the vital contribution of phonics training, consideration should be given to allocating more time in the limited school day to supporting additional aspects of oral language development to develop a more holistic approach to the development of reading comprehension skills.

Support for more focused attention on the development of oral language skills was found in a recent report that investigated the needs of children and young adults with speech, language and communication needs (SLCN) (Lindsay, Dockrell, Law, & Roulstone, 2012). The report suggested that, in addition to targeted intervention for SLCN children, there should be universal provision to support all children in speech, language and communication development in order to foster good oral language skills. A further report aimed to develop a profile of good practice in Reception and Key Stage 1 classrooms to create an effective language-learning environment to provide support for literacy development (Dockrell, Bakopoulou, Law, Spencer, & Lindsay, 2012). Results from the current study suggest that this type of approach would also be beneficial in preschool classrooms to provide effective opportunities and interactions for pre-readers to develop early language skills to support their later acquisition of reading comprehension.

As noted above, the SVR provides a useful framework for understanding the development of skills underpinning reading comprehension. However, consistent with other studies (e.g., Conners, 2009; Johnston & Kirby, 2006; Kirby & Savage, 2008), this current study found that after accounting for the contribution of oral language comprehension and word reading efficiency (including accuracy and fluency of single word and non-word reading) there remained a substantial amount of unexplained variance in reading comprehension. Metacognition has been highlighted as a potential additional factor to the SVR to account for this unexplained variance, as it may support the higher order skills that are specifically required for comprehending written text, e.g., comprehension monitoring and repair (Kirby & Savage, 2008). The current study found that theory of mind accounted for unique variance in later reading comprehension. This contribution may have been indirect via the linguistic component of the SVR or perhaps through shared variance with general language ability. However, early false belief understanding uniquely accounted for variance in later reading comprehension over and above the two dimensions of the SVR. Potentially this early measure indexes general metacognitive abilities, but further research is needed to explore other aspects of metacognition, such as measures of source monitoring (Bright-Paul, Jarrold, & Wright, 2008; O'Neill & Gopnik, 1991) and its later contribution to reading comprehension.

The novel finding that early theory of mind contributed to developing reading comprehension in a typically developing population raises some important implications for preschool home and school environments. Encouraging and supporting children in the development of theory of mind, such as training in

false belief tasks (Lecce et al., 2014), may bring potential benefits, beyond social implications, to influence metacognitive abilities. For example, parents should be informed and encouraged to use mental state talk within the home environment and within home literacy activities, since mental state talk has been shown to facilitate theory of mind development in preschool and pre-adolescence (Hughes, Ensor, & Marks, 2010; Ruffman, Slade, & Crowe, 2002). This may provide a particularly practical, accessible and potentially effective way of promoting and practicing the metacognitive skills needed for later reading comprehension.

Early intervention to address deficits in literacy-related skills is critical to prevent children from experiencing long-term disadvantages (Lonigan, Burgess, & Anthony, 2000; Torgesen, 2002). Therefore, the ability to identify children who may potentially struggle with reading, from their early pre-reading skills, would be a valuable tool (Puolakanaho et al., 2007). However, there are limitations when assessing very young children. Preschool variables, although contributing to two separate predictive pathways in line with the SVR, were highly inter-related. Consequently, it is challenging to assess and measure separate constructs in very young children. Results from the current study suggest that some tasks might have been indexing other abilities, e.g., phonological awareness indexing working memory. Although further clarity is required, the implications of these findings might be useful in assessing preschool children. For example, phonological awareness tasks are relatively easy to administer, whereas assessing working memory and executive skills in a young population is extremely challenging. Further research is needed to unravel the validity of the tasks and to understand exactly, which underlying-processes and skills are being assessed. A creative

approach is needed to adapt and develop sensitive tests for this age group.

Nonetheless, the current longitudinal study has provided important knowledge towards identifying early preschool indicators of later reading comprehension difficulties and strengths. This has important implications not only for early identification of children at risk for developing reading comprehension difficulties and for informing future targeted interventions, but also for informing early years literacy instruction and practices both at school and at home.

7.3 Limitations and considerations

There are a number of limitations to this research that should be noted. Firstly, the children were from a relatively homogeneous population. They attended one of two schools in a middle class area and their parents, in general, had achieved levels of education above the norm (88% of parents had completed a higher education award). The current findings suggest that children experiencing a less rich home literacy environment (HLE), perhaps due to limited materials, resources and time, may be disadvantaged. Therefore, it is important to extend this research to disadvantaged groups to highlight potential differences. This future research may be crucial for informing targeted instruction and intervention to help those children at risk of literacy difficulties posed by low SES. It is also worth noting, however, that previous research has shown that rich home literacy experiences may mitigate the risks of poor literacy skills for children from low SES backgrounds (e.g., Payne, Whitehurst, & Angell, 1994). Therefore, it is possible that investigating the early precursors of literacy development in a

sample of children from low SES backgrounds may strengthen the effects that have been reported in this thesis.

In addition to SES, it should also be noted that there might have been a selection bias, as parents with higher levels of education may have been more likely to consent to the study, and potentially, those with an interest in literacy development may have been more likely to return the home literacy questionnaire. Additionally, although children's home literacy experiences were examined, their experiences outside of the home, e.g., daycare and private nurseries, were not investigated. Although all the children were non-readers at the time of baseline assessments, some children may have been exposed to more literacy-related experiences than their peers.

Secondly, assessing very young children is challenging. Finding age appropriate tests is difficult, often requiring adaptation of existing tasks to achieve adequate sensitivity across different ages. Ceiling and floor effects are major considerations, which may subsequently impact on results. Children's cognitive and socio-cognitive development during the early years involves substantial growth, such that assessment tasks must be carefully selected at each time point and often new, more advanced tasks are required. Although the key measures showed good stability over time, the potential inconsistency of tasks may result in under or over estimation of the stability of constructs across the study. More consistency between measures, particularly composite measures, may have provided greater reliability.

Additionally, as previously noted, cognitive abilities in young children are highly inter-related. As a consequence, some tasks may not be sufficiently sensitive to differentiate between specific abilities and constructs, and to reliably capture the full range of individual differences. Assessing children with a variety of tasks for each construct may achieve greater reliability. Alternative forms of assessments may also have impacted on the results. For example, word reading was assessed using a mixture of regular and irregular words, however, using an assessment that differentiates between the two types (e.g. Diagnostic Test of Word Reading Processes) would have determined the unique contribution of irregular words, which may have provided a more robust measure of word reading accuracy. Similarly, reading comprehension was assessed using a combination of literal and inferential questions (scores for the two types of questions are not separated in the standardized administration of the YARC), however, different factors may underpin proficiency in each type of question, particularly when considering the role of theory of mind (ToM) and executive function skills. For example, ToM may have contributed to inferential questions rather than literal questions. The current study did not examine these differences, but notes that these promising avenues for future research may provide further clarity of the unique contribution of underlying variables to emergent reading comprehension.

Furthermore, research has shown that children's development is uneven and highly influenced by their environment (Shepard, Kagan, & Wurtz, 1998); therefore, ideally, children should be assessed within each construct on multiple occasions. However, as the current study aimed to investigate a broad range of cognitive and socio-cognitive variables, there was a limit to the number of tasks

for each construct. Constraints of time for data collection and children's availability for testing also restricted the number of possible assessment tasks. Assessment sessions were kept short and varied not only to maintain children's attention and interest, but also to comply with ethical and practical implications that required limits to be applied to the number of assessment sessions and number of tests within the sessions. Further research is needed, targeting specific domains, in order to facilitate more comprehensive investigation.

Children were assessed in reading comprehension at six years old, which is younger than typically reported in the literature. Previous research has shown that cognitive variables make their most potent contribution to emergent literacy development at different stages through the early years (Storch & Whitehurst, 2002; Whitehurst & Lonigan, 1998). In other words, inter-relationships between the variables and their independent contribution to reading comprehension are dynamic. Therefore, using reading comprehension performance at six years old as a final outcome measure may not be representative of future abilities. It is also worth noting that some of the children completed the beginner's passage in the reading comprehension task, which involved the researcher reading out part of the passage. Although children went on to read a second passage independently, it did mean that an element of their assessment was testing listening comprehension in addition to reading comprehension. This was an unavoidable difficulty of assessing reading comprehension in this very young sample, but reinforces the importance of continuing the longitudinal research. Children should be regularly reassessed until they become fluent and efficient readers to

gain a complete picture of the development trajectory of emergent literacy and reading comprehension skills.

A further possible limitation was the reliance on regression analyses rather than more sophisticated techniques, such as structural equation modeling (SEM). As discussed, this research investigated a broad range of variables. Practical and time constraints for data collection dictated that the sample size had to be restricted. The longitudinal design of the study inevitably led to attrition, which resulted in a final sample with complete data that was not sufficiently large for the purposes of SEM. Regression analyses were considered to be acceptable for several reasons. First, there is precedent for regression analyses in much of the literature relating to early literacy development, particularly in home literacy research. Secondly, the aim of the study was to extend single models rather than contrast different models. Finally, the research was examining factors from three domains (social, cognitive and social cognitive); therefore complex modeling with a modest sample was not feasible.

However, the use of multiple correlation and regression analyses raised concerns about escalating familywise error rate. Multiple comparisons between intercorrelated variables may have increased the possibility of Type I errors. To address this issue, controlling procedures could have been applied, e.g., Bonferroni correction. There has been precedent in the literature not to adjust for multiple comparisons (e.g., Hood et al., 2008; Sénéchal & LeFevre, 2002) and, with the modest sample size reported in this thesis, there was some concern about taking an over-conservative approach through the application of

Bonferroni corrections, which may have resulted in a reduction of statistical power, and, consequently, an increase in Type II error rate. Nevertheless, it should be noted that the significant relationships reported in this study require replication in larger samples, with a more conservative statistical approach, to fully determine the associations between factors underpinning emergent reading comprehension.

A rigorous approach was taken for the regression analyses, following recommended procedures (Field, 2009; Tabachnick & Fidell, 2007). Residual and influence statistics were examined to identify violations of assumptions of normality and multivariate outliers. The approach taken was to identify and remove outliers per analysis; however, a more systematic approach may have been to remove outliers across the entire dataset at all time points before undertaking any analyses. This approach would have resulted in a normally distributed dataset, but the consequence would have been a reduction in sample size. It is noted, however, that excluding outliers at each time point, rather than across the complete study, may be potentially unsound due to the concurrent and longitudinal intercorrelations between variables.

As stated, this research principally used correlation and regression analyses to examine the data. Supplementing the analyses with additional and alternative statistical approaches may have added benefit, both for informing the underlying structure and relations of variables and, potentially, reducing the need for multiple comparisons. One general approach would have been to use principal component analysis (PCA) as a first step in the analyses to identify key,

independent skill sets. Using PCA at each time point may have reduced the number of variables entered into the regression analyses, which would have, at least partially, addressed the issue of balancing statistical power with rising familywise error rates due to multiple comparisons. Additionally, the examination of the profiles of unexpected poor and good comprehender may be augmented with the addition of a retrospective case series approach. The sample size of each group was very small; therefore caution must be taken when interpreting the results of group means. Retrospective case series may yield further clarity. Alternatively, cluster analysis, using the whole sample, may provide a useful technique to identify profiles of strengths and weaknesses underlying the comprehension ability groups.

Finally, although the novel aspects of this study highlight promising areas for research, further studies are required to clarify and replicate findings. The relationship between early theory of mind and later reading comprehension potentially suggests that early metacognition might be beneficial for the development of reading comprehension skills. However, metacognition was not explicitly measured. Future research must involve alternative measures of metacognition that are independent of language to determine its role in reading comprehension skills. The examination of the profiles of unexpected poor and good comprehenders provided further evidence of the contribution of theory of mind, in addition to highlighting the language weaknesses of poor comprehenders and the relative narrative strengths of good comprehenders. However, as stated above, caution must be taken when interpreting the results because the sample size of each group was very small. Future research with large

cohorts is required to develop this field of research, but potentially this approach could identify the precursors of poor and good comprehension skills, which would inform both instruction and intervention development.

7.4 Future Directions

The current study, despite its limitations, highlighted direct and indirect predictive pathways from preschool home literacy experiences and pre-reading abilities to the acquisition of reading comprehension. Its longitudinal design afforded consideration of *causal* factors underpinning poor and good comprehension. Future research is required to replicate the reported studies, not only within a range of SES groups, but also with larger cohorts to increase statistical power and allow the use of more sensitive analysis techniques. Further longitudinal extension of the research is also crucial. As noted above, the development of emergent literacy is complex and relationships change over time; therefore, children's developing skills should be reassessed until they are fluent and efficient readers.

There is growing evidence reinforcing the importance of the home literacy environment (e.g., Hood et al., 2008; Martini & Sénéchal, 2012; Sénéchal & LeFevre, 2014). This study extended current knowledge of the benefits of direct parental teaching to a younger population, but further clarity is needed to understand how parents use, or could be advised to use, opportunities to teach their children literacy-related skills. Children's interest and motivation is also an important consideration for future research. In general, research has found that an interested child gains more benefit from home literacy experiences than an

uninterested child (Martini & Sénéchal, 2012; Baroody & Diamond, 2012), but mixed results have been reported regarding how children benefit. The current study found that children's preschool literacy interest directly contributed to later language and reading measures, but as children's abilities and parents home literacy practices change over this time (Hood et al., 2008; Silinskas, Leppänen, Aunola, Parrila, & Nurmi, 2010), it is important to understand how children's interest and motivation contribute to their developing reading and reading comprehension skills.

There is a wealth of research examining the development and implications of theory of mind (e.g., Bailargeon et al., 2010; Doherty, 2009; Ruffman, 2014). The current study was the first to find that early theory of mind predicted later reading comprehension, over and above the language and word reading dimensions of the SVR, in a typically developing population. This has highlighted some promising areas for future research. Firstly, to examine whether theory of mind per se is contributing to reading comprehension or whether it is acting as a proxy measure for more general metacognitive abilities. Secondly, how instruction and practice in theory of mind at home and in preschool settings may support the development of early metacognition and later reading comprehension skills. Finally, whether general metacognition accounts for additional variance in reading comprehension beyond that accounted for by linguistic comprehension and word reading, and should therefore be considered as an additional dimension in the SVR.

A general limitation of research examining early literacy development is the inconsistency of definitions of constructs and of the tasks used to assess them. The current study has highlighted the need to develop sensitive, age appropriate tasks for very young preschool children, perhaps using proxy measures for constructs such as executive function that are extremely difficult to measure in very young children. Additionally, it has demonstrated the importance of using a broader range of variables to capture richer measures of language, word reading and reading comprehension skills. A valuable area of future research would be the development of standardized tasks for the home literacy environment and for directly assessing children through the early years. These would afford more reliable comparison between studies and diverse populations to provide a clearer understanding of the complex development of reading comprehension.

7.5 Conclusion

The longitudinal research reported in this thesis adds to a growing body of research that has demonstrated that, consistent with the SVR, reading comprehension is underpinned by two separate sets of cognitive skills (code-related and oral language) contributing to two predictive pathways to later reading comprehension. It extends current knowledge to a younger population to show that the origin of these pathways can be found in the pre-reading abilities of three-year-old preschool children. Furthermore, it demonstrated that children's pre-reading skills at three years were directly and indirectly influenced by their home literacy experiences. Additionally, it found that *both* word reading

and oral language skills are equally crucial for the acquisition of reading comprehension.

Finally, this research found that an additional factor, early theory of mind, potentially as an index of metacognition, contributed to reading comprehension over and above the two components of the SVR, suggesting that the SVR may be too simple to fully account for the acquisition of reading comprehension. The findings of this research have important implications, not only for the early identification of children who are at risk for future reading comprehension difficulties, but also for informing early years literacy instruction and future targeted interventions.

Appendix 1: Head teacher consent letter

Head teacher Consent Form

Title of Research Project: Predicting reading ability in nursery and infant school children

Brief Description of Research Project: Until recently, reading difficulties were generally thought to arise from a single cause: a deficit in phonological knowledge. However, reading is a highly complex task and evidence is now accumulating to suggest the influence of multiple cognitive and socio-cognitive factors in reading acquisition. Although we are beginning to have an understanding of the complexity of these factors there is still much uncertainty about whether they cause the children's reading problems or arise as a consequence of them. It is essential that we fully understand the directly of causality if we are to develop effective interventions. This longitudinal study will specifically address these issues of causality, by assessing children during their nursery year, before they experience any formal reading instruction, and then tracking their performance in reading and reading-related skills as they progress through Reception and the first years of primary school.

We will be carrying out a wide range of assessments to gain an index of the range of skills thought to impact on literacy (e.g., phonological awareness, memory, speeded naming, visual processing, general verbal and non-verbal abilities, social understanding, attention) as well as reading readiness and reading itself. We have prepared a brief description of all the tasks we are using for you and the class teachers, which can be made available to you on request. The first stage of testing will involve obtaining baseline measures of these skills, while the children are in the nursery year. It is anticipated that this will involve three individual test sessions for each child lasting no longer than 15 minutes. The children will then be re-assessed each term during Reception and Year 1, undertaking a maximum of two 15-minute test sessions per term. Assessments will involve a combination of standardized pen-and-paper assessments of reading and reading related abilities (e.g., letter knowledge, phonological awareness), and customized computer measures, which will be presented in the form of enjoyable games. Following each assessment session the researcher will give the child a simple explanation of the purpose of the tasks. In general, the tasks will be largely typical of children's normal classroom activities.

The collected data will be treated entirely confidentially. It will be securely stored in confidential computer files and in locked filing cabinets at Roehampton University and will be accessible only to the study investigators. We aim to use the aggregated data in future academic publications; however this will not include any identifying details of individual children. This is a long-term project, and should you wish to withdraw your school from the study at any later date, please contact us at the address given below and we will remove the children's data from the study. Please note however that

despite withdrawing from the study, data may already have been used in publications relating to this research, though only in aggregate form as part of larger datasets used for statistical analysis.

Investigator Contact Details:

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Psychology
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Consent Statement:

I agree for Fern Hill Primary School to take part in this research, and am aware that I am free to withdraw at any point, by contacting the investigators named above. I understand that the information provided by children at this school will be treated in confidence by the investigators and that their identity will be protected in the publication of any findings.

Name

Signature

Date

Please note: if you have a concern about any aspect of your participation or any other queries please raise this with the investigators. However if you would like to contact an independent party please contact the Dean of School.

The Dean of School Contact Details:

Mr Michael Barham
School of Human and Life Sciences
Roehampton University
Whitelands College
Holybourne Avenue
London SW15 4JD
Tel: 020-8392 3617
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Appendix 2: Opt-out consent letter for parents

Parent/Guardian Consent Form

Title of Research Project : Predicting reading ability in nursery and infant school children.

Brief Description of Research Project

Recent research has given us an understanding of the complex range of factors associated with reading development; however there is still much uncertainty about whether children's ability in these factors causes the differences in reading ability or arises as a consequence of them. To develop effective remedial intervention for children who struggle with literacy, it is essential to have a clearer picture of which factors actually help and/or hinder children's early reading and spelling, by assessing these skills in typically developing children attending mainstream schools. This project is addressing this issue by assessing very young children before they experience any formal reading instruction, and then tracking their performance in reading and reading-related skills as they progress through the early years. We are delighted that Miss Brotherston has agreed for Fern Hill to participate in this research.

We will be carrying out a wide range of assessments to gain an index of the range of skills thought to impact on literacy (e.g., phonological awareness, memory, speeded naming, visual processing, general verbal and non-verbal abilities, social understanding, attention) as well as reading readiness and reading itself. The first stage of testing will involve obtaining baseline measures of these skills, while the children are in the nursery year. It is anticipated that this will involve some individual test sessions for each child lasting no longer than 15 minutes each, to be carried out in a quiet area in or near the classroom as part of the daily classroom activities. The children will then be re-assessed each term during Reception and Year 1, undertaking a maximum of two 15-minute test sessions per term. Assessments will involve a combination of standardized pen-and-paper assessments of reading and reading related abilities (e.g., letter knowledge, phonological awareness), and customized computer measures, which will be presented in the form of enjoyable games. The researcher will give a simple explanation of the purpose of the tasks to the child after each assessment session. In general, the tasks will be largely typical of children's normal classroom activities.

Some of the information we collect will be very useful to the school and we will therefore pass it on to them; however all data will be treated entirely confidentially and your child's name will never be linked with his or her scores on any of the tasks that they complete. The collected data will be securely stored in confidential computer files and in locked filing cabinets at Roehampton University and will be accessible only to the study investigators. We aim to use the aggregated data in future academic publications; however this will not include any identifying details of individual children. This is a long-term project, and if you or your child should wish to withdraw from the study at

any later date, please contact us at the address given below and we will remove all your child's scores from our dataset. Please note however that despite withdrawing from the study, data may already have been used in publications relating to this research, though only in aggregate form as part of larger datasets used for statistical analysis. All researchers working on the project will have full Criminal Records Bureau clearance.

If you are willing for your child to take part in the study you do not need to contact us; however if you have any objection to your child taking part please complete the attached form and return it to your child's class teacher. During the study we will send you updates, but if you would like any further information in the meantime please contact us at the addresses below.

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Roehampton Research Project: Predicting reading ability in nursery and infant school children.

I/we would prefer my/our child **not** to take part in the reading research project.
(Please only complete this form if you object to your child taking part in the research study; you do not need to respond if you are happy for your child to participate.)

Name of child:

Name of parent/guardian:

Signature:

Date:

Please note: if you have a concern about any aspect of your child's participation or any other queries please raise this with the investigator. However if you would like to contact an independent party please contact the Head of Psychology.

Contact Details:

Dr Diane Bray
Head of Psychology

Appendix 3: Example of update letter for parents

Dear Parents / Guardians

Reading Research Project Update (September 2011)

As you may remember, we are researchers from the University of Roehampton running a project investigating the reading development of typically developing children in mainstream schools. Over the past two years we have worked with the children at Fern Hill, beginning with the first group of children as they joined the school in September 2009. As this type of research is crucial to our understanding of the complex nature of reading, we are extremely grateful for your cooperation and your child's participation. Ultimately, the study will help us to understand the difficulties experienced by other children, with the aim of providing early targeted intervention techniques to help them.

During 2009/10 we began the project by looking at the children's pre-reading skills during their nursery year and continued to monitor their progress through the following reception year. This year we plan to observe the children's developing reading and comprehension skills as they work towards becoming independent readers during Year 1. The second group of children joined the Nursery last year and, this year, we will follow their progress through their reception year. Our work with the children involves short individual sessions at two or three time points during the year. The tasks in these sessions are similar to classroom activities and designed to be enjoyable for the children. Please be assured that all the data we collect will remain entirely confidential and when reporting on our research findings we will never identify individual children and will always use aggregate group data only.

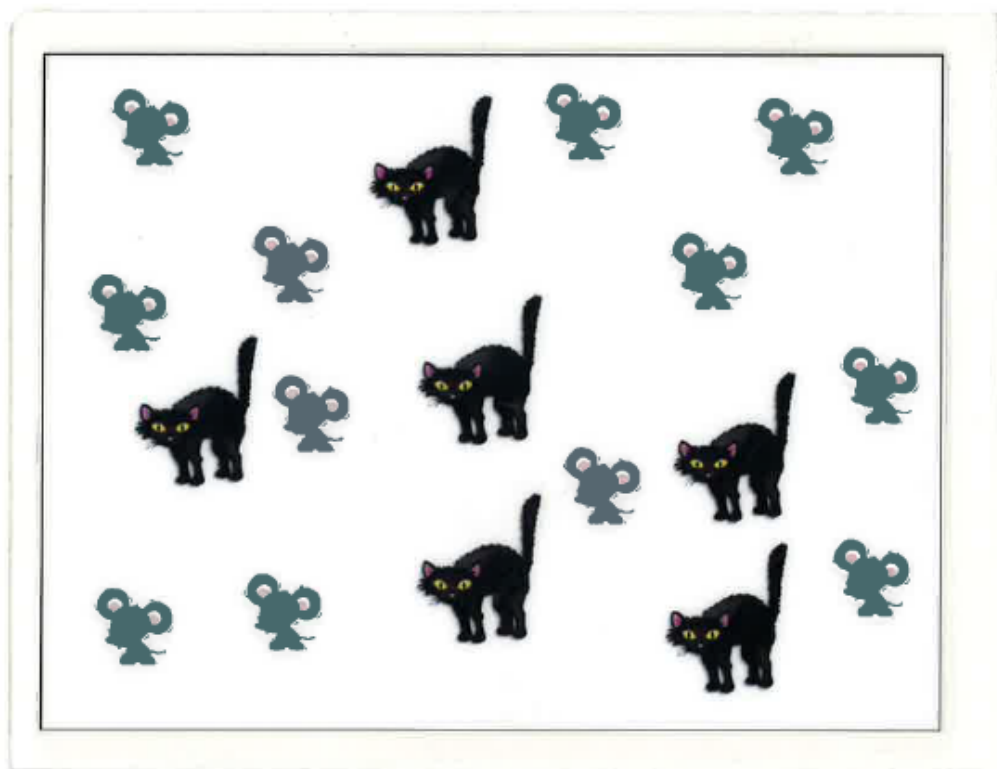
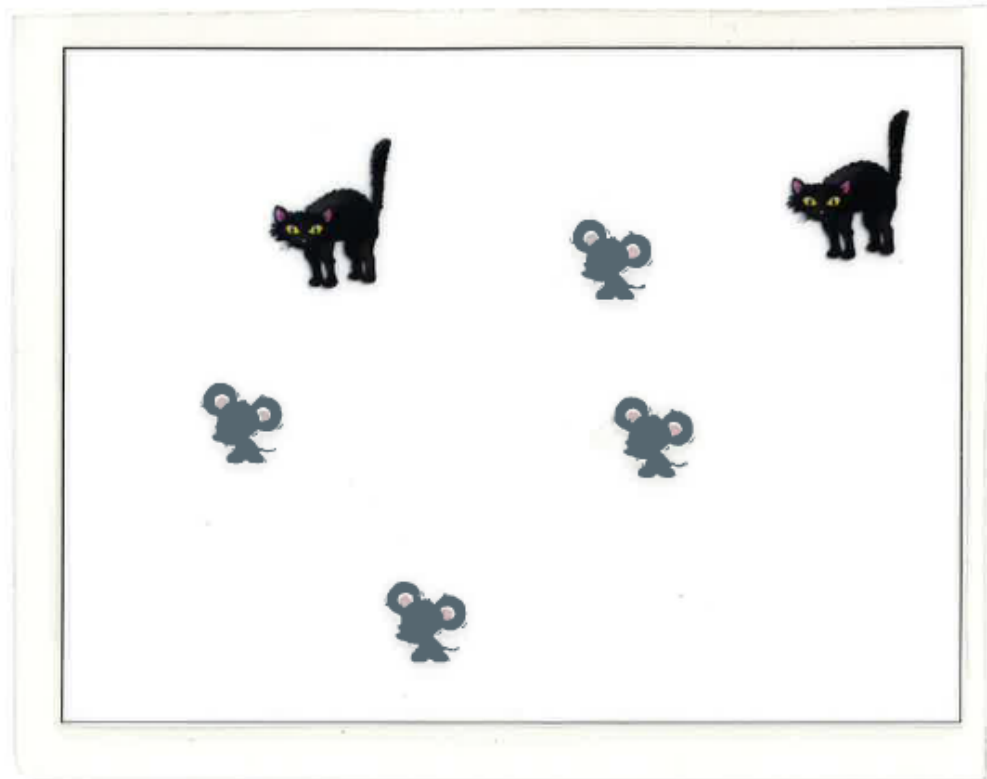
Although full analysis of the study will be reported at the completion of the project, we have been able to carry out some preliminary analysis looking at the links between home literacy and early pre-reading skills. These initial findings were presented at an international research conference during this summer and are making an important contribution to this vital area of research. Once again, thank you for your child's participation and for your help in our project. We believe that it is an essential area of research; by studying typically developing readers in mainstream classrooms, we aim to learn how to identify as early as possible those children who are struggling with reading. Another long-term goal is to develop targeted remediation, which would be a huge step forward in helping those children affected by reading disorders.

If you have any queries or would like further information please do not hesitate to contact us at the address above.

Dr Daisy Powell

Lynette Chesson

**Appendix 4: Cat and mouse working memory task
(example of stimuli and administration scripts)**



Cat & Mouse Task 1

Condition 1 (Small Card Last)

Name:

Participant No:

Class:

Group:

Date of birth:

Today's date:

Materials

3 x sets of counting cards (1 – 6)

Procedure

Practice Trial (*Use a 6 cat card and a 1 cat card*)

"Now we are going to play a remembering game and you are going to do some counting."

Using the 6 cat card. "What is this (*pointing to a cat*) and what is this (*pointing to a mouse*)?"

"Can you count the cats?" (*Help to count if necessary*) "So how many are there?"

"Now I'm going to turn this card over, but try to remember how many cats there are because I am going to ask you to remember in a minute." (*Turn card over*)
"How many cats were there?"

(*Introduce new 1 cat card*). "How many cats are there?" (*Turn card over*)

"Now can you remember how many cats were there on the first one that you saw?" (*Prompt if necessary*). "And how many cats there were on the second?"

If correct move on to test trials. If incorrect repeat practise trial.

Test Trials

Record child's response for counting totals and recall totals.

Set 1 – (2 cards)

Score 1 point for two correct recall totals and 1 additional point for correct order.

Trial 1 (5 cats / 3 cats)

Card Sequence	No of cats	Counting total	Recall Total	Score
1	5			
2	3			0 1 2

Trial 2 (4 cats / 1 cat)

Card Sequence	No of cats	Counting total	Recall Total	Score
1	4			
2	1			0 1 2

Trial 3 (6 cats / 2 cats)

Card Sequence	No of cats	Counting total	Recall Total	Score
1	6			
2	2			0 1 2

If 2 of above 3 trials correct, move on to **set 2**, otherwise discontinue testing for this condition.

Set 2 - (3 cards)

Score 1 point for two correct recall totals, 2 points for 3 correct recall totals and 1 additional point for correct order.

Trial 1 (4 cats / 5 cats / 2 cats)

Card Sequence	No of cats	Counting total	Recall Total	Score
1	4			
2	5			
3	2			0 1 2 3

Trial 2 (6 cats / 4 cats / 1 cat)

Card Sequence	No of cats	Counting total	Recall Total	Score
1	6			
2	4			
3	1			0 1 2 3

Trial 3 (5 cats / 1 cat / 2 cats)

Card Sequence	No of cats	Counting total	Recall Total	Score
1	5			
2	1			
3	2			0 1 2 3

Total score: (max score 15)

Cat & Mouse Task 2

Condition 2 (Large Card Last)

Name:

Participant No:

Class:

Group:

Date of birth:

Today's date:

Materials

3 x sets of counting cards (1 – 6)

Procedure

Practice Trial (*Use a 6 cat card and a 1 cat card*)

"Now we are going to play a remembering game and you are going to do some counting."

Using the 6 cat card. "What is this (*pointing to a cat*) and what is this (*pointing to a mouse*)?"

"Can you count the cats?" (*Help to count if necessary*) "So how many are there?"

"Now I'm going to turn this card over, but try to remember how many cats there are because I am going to ask you to remember in a minute." (*Turn card over*)

"How many cats were there?"

(*Introduce new 1 cat card*). "How many cats are there?" (*Turn card over*)

"Now can you remember how many cats were there on the first one that you saw?" (*Prompt if necessary*). "And how many cats there were on the second?"

If correct move on to test trials. If incorrect repeat practise trial.

Test Trials

Record child's response for counting totals and recall totals.

Set 1 – (2 cards)

Score 1 point for two correct recall totals and 1 additional point for correct order.

Trial 1 (3 cats / 5 cats)

Card Sequence	No of cats	Counting total	Recall Total	Score
1	3			
2	5			0 1 2

Trial 2 (1 cats / 4 cat)

Card Sequence	No of cats	Counting total	Recall Total	Score
1	1			
2	4			0 1 2

Trial 3 (2 cats / 6 cats)

Card Sequence	No of cats	Counting total	Recall Total	Score
1	2			
2	6			0 1 2

If 2 of above 3 trials correct, move on to **set 2**, otherwise discontinue testing for this condition.

Set 2 - (3 cards)

Score 1 point for two correct recall totals, 2 points for 3 correct recall totals and 1 additional point for correct order.

Trial 1 (2 cats / 5 cats / 4 cats)

Card Sequence	No of cats	Counting total	Recall Total	Score
1	2			
2	5			
3	4			0 1 2 3

Trial 2 (1 cat / 4 cats / 6 cats)

Card Sequence	No of cats	Counting total	Recall Total	Score
1	1			
2	4			
3	6			0 1 2 3

Trial 3 (2 cats / 1 cat / 5 cats)

Card Sequence	No of cats	Counting total	Recall Total	Score
1	2			
2	1			
3	5			0 1 2 3

Total score: (max score 15)

Appendix 5: The title recognition task (TRT)

Title Recognition Task

My Sister's Snail	F	Stanley and the Duck	F
Mog the Forgetful Cat	T	The Kitten with the Dream	F
Ring Ring Who's There?	F	Dear Zoo	T
We're Going on a Bear Hunt	T	The Bear Under the Stairs	T
Owl Babies	T	The Gruffalo	T
Under the Deep Blue Sea	F	Rosie's Farmhouse	F
The Very Hungry Caterpillar	T	The Dolphin Who Didn't Like Water	F
Maggie and the Wolf	F	The Tiger Who Came to Tea	T
The Little Pink Dress	F	The Adventure Gone Wild	F
Monkey Puzzle	T	Charlie in the Jungle	F
The Big Light in the Sky	F	Each Peach Pear Plum	T
Burglar Bill	T	The Bad-Tempered Ladybird	T
John and Edward's Hair Adventure	F	My Naughty Little Sister	T
Not Now Bernard	T	Dogger	T
Bag It!	F	Grandma's Bedroom	F

Scoring

Score one point for each target (T) title correctly recognised. Sum to give 'T' score (max=15).

T/ 15 =

Score one point for each foil (F) title incorrectly recognised by the child. Sum to give 'F' score (max=15).

F/ 15 =

Total (T – F) =

Appendix 6: Bus story (Renfrew & Hancox, 1997) – example of coding

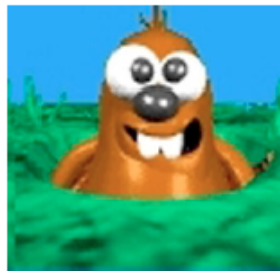
INFORMATION SCORING GUIDE		TRANSCRIPTION		SENTENCE LENGTH	
Bold type = 2 points (1 point if half response is correct) Normal type = 1 point					
bus	naughty	1	Once up a time there was a bus.	9	
driver	mending/fixing	2	And the man who was driving the bus mended it.	8	
bus	ran away/drove off met/ran with train made faces raced	2	But the bus ran off away from him. The bus met a train.	8	
train	in tunnel	2	And they were playing silly faces and doing faces.	6	
bus	alone into city/street met/saw policeman	1	And the train went into a tunnel.	6	
policeman	blew whistle said Stop	2	And then the bus went away.	9	
bus	paid no attention ran on/didn't stop into country tired of/bored with road jumped over fence/gate met/saw cow	2	But the bus didn't stop.		
cow	moo not believe eyes	2	The bus wanted to go next on the road.		
bus	went downhill saw water tried to stop didn't know how to brake/stop fell in water splash stuck in mud	1	Then he jumped over a fence.	6	
driver	found bus/him rang for crane	2	And then he saw a cow.		
crane	lifted out/pulled up	1	And the bus was going.		
bus	back on road	1	And he was going down a hill.		
		2	But he was trying to stop but he couldn't.		
		2	And then he went in some water in the water and the mud.		
		1	(He couldn't put his brakes on).		
		1	He went down the hill and pulled him up.	7	
TOTAL		28		43/5	0
				ABLS	8.6

Appendix 7: Wack-a-mole go/no go task

Wack-A-Mole Instructions for children

“You’re going to play a computer game where your job will be to stop a mole from digging up your garden. The way that you wack the mole is by pressing the spacebar when the mole appears on the screen.”

“This is what the mole will look like.” Show them the cue card of the mole stimuli.



Ask them to show you which button they would press on the keyboard when the mole appears.

“The mole will try and trick you by wearing clever disguises. Don’t be fooled by the sneaky mole. Be sure to wack the mole as fast you can before he gets away.”

“Sometimes, a vegetable will pop up in your garden. This is what the vegetable will look like.” Show them the cue card of the vegetable stimuli.



“Remember to wack the mole as fast as you can, but don’t wack the vegetable!”

When the subject understands the directions, go on to the practice trials. Tell them that they will see an empty hole in between trials, and that they should focus on the hole. Remind them to wack the mole as fast as they can, but not so fast that they make mistakes. They get the “awesome” feedback on the screen when they correctly withhold a response and you can also give them verbal feedback on the practice trials. In between each block the subject can choose to take a short break or continue, but they should not take breaks within the blocks, only between them.

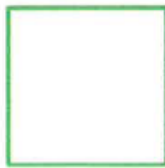
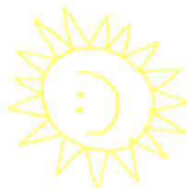
Appendix 8: Stimuli for unexpected location second-order false belief task

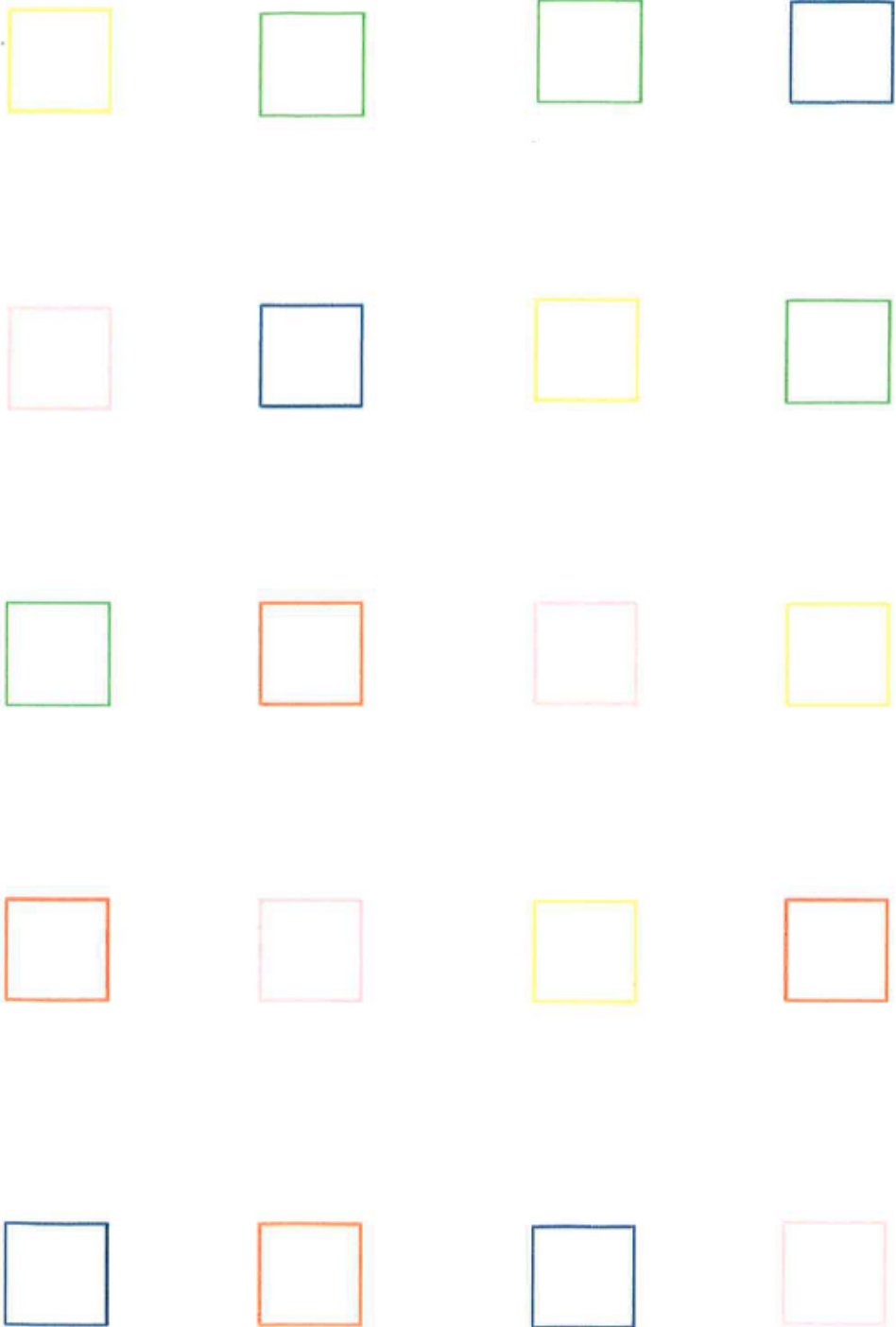




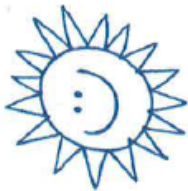
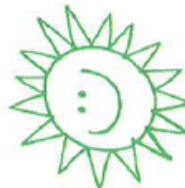
Appendix 9: Colour-object switch - cognitive inhibition task (stimuli and script)

Practice









Colour/Object Switch Task

Materials: Stopwatch, practice page (page 1), colour naming page (test 1, page 2), object naming page (test 2, page 3) and colour (coloured objects) naming (test 3, page 4).

Scoring: The score for this task will be the difference (secs) between test 3 and the mean of test 1 and test 2.

Directions

Practice: Show practice page 1, point at the top row of colours and say "What colours do you see on this page?" (if the child makes any errors, correct the child, and ask him/her to repeat all the colours again).

Then say, look down here at these pictures. What are the pictures? (if the child makes any errors, correct the child, and ask him/her to repeat all the picture names again).

Test 1

Test: Say "Now I want you to say the names the colours on this page as fast as you can. When I tell you to start, you will begin here (point to upper left corner of colour page), and name this row (point to top row) before you go on to the next row. Just try to name the colours in each row as fast as you can until you come to the end. Try not to skip any of the colours. Do you understand?"

Put a blank sheet on top of the page to cover the colours for about 5 seconds. Say "You will begin as soon as I uncover the page. Ready? Begin"

Quickly take cover off the page, and start timing as soon as the child says the first colour name. Stop timing when the name of the last colour is pronounced. Keep track of errors by putting a line through each wrong item. When the child is finished, record time and errors.

Test 1: blue	orange	green	pink	yellow
orange	pink	orange	blue	green
blue	yellow	pink	yellow	green
pink	orange	yellow	green	blue

Test 1 time =

Errors =

Test 2:

Test: “Now I want to say the names of the things on this page. When I tell you to start, you will begin here (*point to upper left corner of the first picture*), and name this row (*point to top row*) before you go on to the next row. Try to name the pictures in each row as fast as you can until you come to the end. Try not to skip any of the pictures. Do you understand?”

pig	whale	carrot	frog	sun
carrot	sun	whale	pig	whale
sun	frog	carrot	sun	frog
pig	carrot	frog	whale	pig

Test 2 time =**Errors =**

Test 3:

Test: Say “Now we’re going to do colours again. I want you to say the names of the colours on this page, not the names of the shapes. When I tell you to start, you will begin here (*point to upper left corner of coloured shape page*), and name this row (*point to top row*) before you go on to the next row. Try to name the colours in each row as fast as you can until you come to the end. Try not to skip any of the colours – and remember, on this go your telling me the COLOURS – you’re not telling me what the things are in the pictures. Do you understand?”

pink	blue	orange	yellow	green
blue	green	blue	orange	yellow
orange	pink	green	blue	yellow
pink	yellow	orange	green	pink

Test 3 time =**Errors =**

Score

Test time 1 _____

Test time 3 _____

Test time 2 _____

Mean T1 & T2 _____

Mean = _____

Score _____

Appendix 10: Examples of Strange Stories (Happé, 1994; O'Hare et al., 2009)

Strange Stories – Faux pas



Sally has short blond hair. She was at her Aunt Carol's house. The doorbell rang. It was Jack, a neighbor. Jack said, "Hello." Then he looked at Sally and said, "Oh, I don't think I have ever met this little boy. What's your name?" Aunt Carol said, "Who'd like a cup of tea then?"

Question 1. Faux pas (Sally and Jack)

1. In the story did someone say something they should not have said?
2. What was said that should not have been said?
3. How does Sally feel now?
4. Did Jack want to upset Sally?
5. Whose house was Sally at?
6. Did Jack know that Sally was a girl?

Strange stories - Misunderstanding



A burglar has just robbed a shop and is making his getaway. As he is running home, a policeman on his beat sees him drop his glove. He doesn't know the man is a burglar; he just wants to tell him he dropped his glove. But when the policeman shouts out to the burglar, "Hey you, Stop!" the burglar turns round, sees the policeman and gives himself up. He puts his hands up and admits that he did the break-in at the local shop.

Question 6. Belief-based Misunderstanding (Burglar and Policeman)

1. Was the policeman surprised by what the burglar did?
2. Why did the burglar do this, when the policeman just wanted to give him back his glove?

Appendix 11: Home literacy environment questionnaire

Note: The percentage scores under each question represent the distribution of responses across the full sample

Literacy at Home

1. How often do you, or other members of the family, read to your child in a typical week? *(Please circle appropriate response)*

At bedtime:

__never	__once	__2	__3	__4	__5	__6	__7
0	0	3.6%	3.6%	3.6%	7.1%	9.5%	71.4%

Other times:

__never	__once	__2	__3	__4	__5	__6	__7	__more
1.2%	1.2%	15.5%	17.9%	20.2%	16.7%	2.4%	14.3%	8.3%

2. During a typical week, how often does your child ask to be read to? *(Please circle appropriate number)*

	Never	Seldom	Sometimes	Often	Very Often
My child asks to be read to:	0	2.4%	22.6%	38.1%	35.7%

3. How frequently does your child visit the library? *(Please circle appropriate number)*

	Never	Seldom	Sometimes	Often	Very Often
My child goes to the library:	15.5%	20.2%	34.5%	21.4%	8.3%

4. Please estimate the number of children's books that are available in the household. *(Please circle appropriate number)*

Number of children's books:

__none	__1-20	__21-40	__41-60	__61-80	__more
0	6%	3.6%	20.2%	35.7%	34.5%

5. How old was your child when you started reading picture books to him/her?

Please estimate age: __Mean age 6.98 months (SD = 5.7 months)

6. During a typical week, how often do you engage in the following activities? *(Please circle appropriate number)*

	Never	Seldom	Sometime	Often	Very Often
I teach my child:					
• to write words (e.g., own name) :	4.8%	9.5%	39.3%	38.1%	8.3%
•					
• to read words:	6%	16.7%	40.5%	23.8%	13.1%
•					
• to play rhyming games:	6%	14.3%	34.5%	23.8%	21.4%

7. During storybook reading, how often does your child engage in the following activities?
(Please circle appropriate number)

	Never	Seldom	Sometimes	Often	Very Often
My child will:					
• name pictures:	0	2.4%	9.5%	36.9%	51.2%
•					
• point at letters/words:	3.6%	8.3%	28.6%	33.3%	25%
•					
• read aloud letters/words:	6%	13%	31%	24%	9%
•					
• ask meaning of words:	3%	21.4%	33.3%	29.8%	11.9
•					
• comment on the story:	1.2%	0	14.3%	35.7%	48.8%
•					
• guess ending of story:	6%	27.4%	26.2%	21.4%	17.9%
•					
• retell story in own words:	4.8%	10.7%	29.8%	29.8%	25%

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